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Children's Access and Use of Digital Resources

Allison Druin, Issue Editor

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Introduction

Allison Druin

The Digital Landscape for Children

Today children expect to find computers in libraries as much as they expect to find books (Douglas, 2002; Meyers, 1999; McIntyre, 2002; Hughes-Hassell & Miller, 2003). Young people assume it is normal to have access in their homes and schools to digital materials from such places as the U.S. Library of Congress, the Smithsonian, and their local public libraries. For school projects, home entertainment, and social experiences, children access and use digital tools and information as a critical part of their lives. Various studies show that young people (ages three to thirteen) have an extremely positive view of new technologies and believe that these digital tools can help them in defining their personal and cultural identities (Media Awareness Network 2000; Howe & Strauss, 2000; Manuel, 2002; Soloway, 1991; Walter, 2001). Children can better understand who they are in their increasingly complex multicultural world through the use of Internet resources (Howe & Strauss, 2000; Raseroka, 2003). Children can also be alerted to potential safety hazards (for example, violent crimes, environmental health hazards, Internet porn) through the use of technology (Walter, 2001, 2003). In addition, new digital information resources can foster learning that can challenge traditional educational structures and processes for children (Jonassen, Peck, & Wilson, 1999; Neuman, 2003; Walter, 2001).

Today's digital landscape can also be problematic for young people. Children see the world differently than adults; they have very different needs for technology and are quite diverse in their abilities, even in the age span of a few short years (Bilal 2002; Cooper, 2002; Moore & St. George, 1991; Siegler, 1998). Unfortunately, it is common that many new technologies do not take children's specialized needs into consideration, and therefore the access and use of digital materials can be challenging for

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children (Druin, 2002). While there is an emerging and growing area of research that addresses these information science and technology issues for children, this work is still relatively new.

In 1997 a seminal issue of *Library Trends* was published that focused on "Children and the Digital Library" (Jacobson, 1997). At that time the Web was only four years old. A majority of public libraries and schools did not have access to the Internet, and the notion that children can contribute to the development of digital services was far from being discussed. Today things have changed. Online access for children has become commonplace, and researchers in various disciplines are interested in how children can contribute to designing future new technologies and new forms of libraries (Bilal, 2002; Large, Beheshti, & Rahman, 2002; Druin, 2002).

In This Issue

Based upon today's digital landscape, four questions are examined throughout the articles in this issue:

- How do new digital tools and materials impact children as information seekers, learners, and creators of their own digital experiences?
- How are the environments of children (for example, in homes, public spaces, school and public libraries) impacted by digital resources now available?
- How are children involved in changing new technologies, and what can be learned from these experiences?
- What new technologies are being developed, and how can these be used as building-blocks for future research?

In this issue some articles address many of the questions stated above, while other articles focus on one specific question more deeply. The articles' authors are many of the leading researchers in this growing yet still small field concerning children. Their work falls into two broad areas: issues concerning children's information access, and children's use of digital materials. All too often researchers consider just one aspect, yet children themselves are most interested in access issues when information use is possible (Druin et al., 2001). Therefore, this issue reflects the interests of children and offers both perspectives.

The first four articles focus on children's access to digital resources through information seeking in general or virtual reference experiences in particular. Eliza Dresang from Florida State University begins this issue by giving an overview of "The Information-Seeking Behavior of Youth in the Digital Environment." She uses the theory of "Radical Change" to discuss the challenges young people have in information seeking along with issues concerned with gender and the use of various story media. She explores the principles of interactivity, connectivity, and access to offer the reader

various perspectives on children's relationship with technology and digital materials. Dania Bilal from the University of Tennessee follows with her article, which focuses the discussion on "Children's Information Seeking and the Design of Digital Interfaces in the Affective Paradigm." Dania brings together an interdisciplinary body of literature to present a framework for considering the role that affect can play in children's information seeking. She also ties this to her own current research and presents findings from her empirical work with children.

The next two articles focus on a particular method of information seeking: virtual reference transactions. In "Teens Are from Neptune, Librarians Are from Pluto: An Analysis of Online Reference Transactions," the challenges of virtual reference experiences are presented. This empirical study by Virginia Walter and Cindy Mediavilla from University of California, Los Angeles makes use of virtual reference system transcripts to offer a glimpse into the information-seeking behaviors of teens concerned with homework preparation and the reference responses of librarians. This study suggests some important lessons not only for librarians but for the designers of virtual reference systems as well. Issues concerned with younger children and virtual reference are discussed further in the article "Just Curious: Children's Use of Digital Reference for Unimposed Queries and Its Importance in Informal Education" by Joanne Silverstein from Syracuse University. In her work, Joanne uses a different virtual reference system to understand what children's information-seeking experiences are like in informal learning settings. This empirical study points to specific areas of concern for children's questions, possible ways to address future new systems design, and critical issues for virtual reference librarians in the future.

The second section of this issue is focused on children's use of information. These articles are concerned with how people use digital resources in numerous contexts, including international locations, as well as how new resources should be designed for use in the future. The first article of this section discusses the "Initial Findings from a Three-Year International Case Study Exploring Children's Responses to Literature in a Digital Library" and is written by Sheri Massey, Ann Carlson Weeks, and Allison Druin from the University of Maryland. This article presents a case study with children from four countries and their reactions to reading books from a digital library. Insights are offered into children's use of digital materials, and possible research directions are suggested for children's recreational reading. The second article in this section is also a case study, but Claire McInerney from Rutgers University takes a broader look at using digital materials and studies an entire town's integration and use of technology. In her article, "Educational Inquiry and Creativity: Developing Digital Resources in Ireland's Information Age Town," she examines the challenges and successes in bringing technology into classrooms and curriculum.

The next two articles in this section review diverse literature with the goal of creating appropriate technologies and information structures for children. Linda Cooper from the Pratt Institute begins by discussing "Developmentally Appropriate Digital Environments for Young Children." In her article she brings together the literature on cognitive, physical, social, and emotional development to suggest that these factors can critically impact a child's ability to interact successfully with digital environments. She summarizes what should be done to address these findings with "design responses supportive of development." June Abbas from the State University of New York–Buffalo follows with her article focused on "Creating Metadata for Children's Resources: Issues, Research, and Current Developments." From a discussion of the literature, June presents the challenges of knowledge representation for children's information seeking and the possible approaches to creating metadata and controlled vocabularies to appropriately support young people.

The final article in this issue considers children's information use but with the goal to develop new, more appropriate technologies for children. In their article, "Interface Design, Web Portals, and Children," Andrew Large and Jamshid Beheshti from McGill University present their research experiences in designing new Web portals for children. By involving children in the design process along with more traditional research methods, Large and Beheshti propose a set of design guidelines for developing future new technologies.

In summary, what all of the articles in this issue have in common is a respect for children. Each of the authors appreciates how children differ from adults, what children's needs can be, and what impact this information should have on future research.

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The Information-Seeking Behavior of Youth in the Digital Environment

Eliza T. Dresang

Abstract

The theory of Radical Change, which is based on the digital age principles of interactivity, connectivity, and access, is suggested as a lens to reexamine existing research on youth information-seeking behavior in the digital environment. After a brief review of research meta-analyses, which often point to deficits in youth information-seeking behavior, questions that emerge from this research are suggested. Meta-analyses of gender and information behavior studies find that some recent research disputes former conclusions. Radical Change is applied to an examination of specific facets of contemporary research in order to demonstrate how new perspectives can be gained. This analysis addresses commonalities between information-seeking behavior related to the handheld book with hypertextual qualities and digital materials, the social nature of information seeking, and emerging issues of access. It is noted that the public library as a setting for research has rarely been used, even though its less structured nature might provide insights that do not surface in schools. A look at directions for youth information-seeking behavior research in the future proposes how brain research might shed further light on behavioral observations. Conclusions note existing research and summarize some new points of view and areas for investigation.

Introduction

An up-to-date overview of research conducted during the past decade related to youth information-seeking behavior in a digital environment reveals challenges and opportunities. A theoretical examination of some of

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the studies provides new perspectives on research findings that have been overlooked and areas that are ripe for study.

Discussion of Terms

In this study, "information" refers to ideas or thoughts that individuals contribute, seek, or obtain from informal or formal discussion, investigation, or study. The whole of information behavior is a complex combination of factors. According to Wilson (1997), who is regarded as a founder of the study of information behavior, at least three facets must be considered. The focus will not be on the perceived need for information or on factors that affect the individual's response to this need but rather on the processes or actions, including information uses, involved in responding to the need.

The fully emerged digital age with a saturated digital environment did not occur until digital media (media with an embedded microchip) started to touch the lives of the general populace in the last decade of the twentieth century (Dresang, 1999b). In his book *Being Digital,* Nicholas Negroponte (1995) of the MIT Media Lab wrote, "Computing is not about computers any more. It is about living" (p. 8). Negroponte and Dresang purport that the impact of the microchip extends beyond direct contact with digital media to influence how one gives, receives, and creates information. The digital environment is ubiquitous; it permeates everyday life.

Young people in the early twenty-first century are "growing up digital," a term applied by Don Tapscott (1997) to those who were born after 1977 and who have experienced a life in which computers are commonplace. With the same Internet-generation youth in mind, Holloway and Valentine (2001) coined the word "cyberkids" to describe young people whose lives are inextricably bound up with an Internet-saturated setting. The information-seeking behavior of these cyberkids, growing up digital, has raised numerous questions among researchers and educators.

The Evolution and Application of Radical Change Theory

In the 1997 issue of *Library Trends, Children and the Digital Library,* Dresang (1997) introduced the theory of Radical Change for the first time in a scholarly publication. The thesis then—and now—is that the term "digital materials" refers not only to those media that incorporate the technology of the microchip but also to "handheld" materials that embody characteristics of the digital environment. In other words, the digital environment has influenced some nondigitized media to take on digital characteristics. Initially Dresang developed the Radical Change theory to explain the changes in handheld books for youth that reflect the interactivity, connectivity, and access of the digital world (Burnett & Dresang, 1999; Dresang, 1997, 1999b, 2003; Dresang & McClelland, 1999; Nodelman & Reimer, 2003). In the 1997 article, she applied Radical Change to explain this reflection of the digital environment in only one type of "change" in the handheld book, that is, forms and formats that reflect the hypertextual,

multilayered, and graphic interfaces of the computer. Subsequently she described two other types of changes that are observed in books influenced by the digital environment: perspectives that incorporate previously marginalized populations, including those of youth; and expanded boundaries that encompass new types of communities, characters, and subjects previously forbidden. These Radical Change books serve as one example that the influence of the digital environment extends far beyond the digital resources themselves.

But other developments have occurred in relation to the Radical Change theory since that 1997 article (Fisher, Erdelez, & McKenzie, 2005). Researchers in the fields of information studies and information science (Agosto, 2002; Dresang, 1999a) have noted that information seeking in a digital environment influenced by digital age principles may call for new perspectives. In the field of education, several researchers (Abele, 2003; Hammerberg, 2001; Pantaleo, 2002, 2004a, 2004b, 2004c) have applied the Radical Change principles to examine or explain not only books but also information behaviors. John Zbikowski (University of Wisconsin–Whitewater) used Radical Change to explicate "the relationship between information and communication technologies and literacy development in and out of schools" (personal communication, March 2, 2003), and Judith Ridge (University of Sydney) found Radical Change useful in exploring creative writing (personal communication, February 18, 2004).

Radical Change, then, is a theoretical concept that applies digital age principles to explain both some information resources and some information behaviors. These digital age principles are further described in the relevant sections below.

After an overview of the current state of research, the theory of Radical Change is applied to examine and explain selected areas of youth information seeking in a digital environment with the purpose of lending additional insights on which researchers and professionals might capitalize.

Information-Seeking Behavior in a Digital Environment: Meta-Analyses

Enough studies have been conducted during the past decade to warrant meta-analyses of youth information-seeking behavior in a digital environment. Research has focused on attitudes and preferences, search processes, modes and skills, and perceived relevance of results; it has been carried out with specific age groups and disaggregated by gender. Schools have been the most common setting for this research, with few studies in public library settings. Research on youth and digital media, which first focused on Online Public Access Catalogs (OPACs) and CD-ROMs, more recently has turned to the Web as the medium.

General Studies

Bilal's (2004) examination of research focuses first on children's tasks—self-generated (see Gross, 1999), fact, or research—when approaching the Web. She analyzes their success and their strategies (or lack thereof), referring to her own seminal research on children's use of the Yahooligans! Web search engine (Bilal, 2000, 2001, 2002). What little is known about children's experience and domain knowledge as relevant to success (Marchionini, 1989) is covered. She concludes that more research is needed on measures of children's success; on the effect of the structure of tasks; on children's prior abilities related to results; on the influence of cognitive styles and mental models; and on children as designers of interfaces. A complementary meta-analysis piece (Large, 2004) focuses exclusively on elementary age children's Web searching.

Todd's (2003) meta-analysis of adolescents' information seeking and use scholarship provides a theoretical approach with an international point of view to three aspects of the topic, one of which is "searching or surfing the World Wide Web" (pp. 38–39). Another meta-analysis (Shenton & Dixon, 2004) focuses on commonalities of information-seeking behavior, regardless of the source, although specific issues related to digital resources are incorporated.

Taken as a whole, the bottom line of these general meta-analyses of information-seeking behavior related to children's *use* of digital media might be that young people are missing much of the richness of an environment saturated with information because of poorly developed information-seeking skills or a propensity to take the easiest path possible. Some researchers, for example, Bilal (2004), offer ample, plausible, youth-related explanations for these tendencies. One implication for practice surely is the one made by Todd (2003), who noted that "a consistent theme emerging from all these studies is the need to develop learners' information and critical illiteracies" (p. 38).

As Bilal points out, a study that she and Kirby (2002) conducted documents that children have "cognitive developmental abilities, problem solving skills and information needs that vary from those of adult users" (Bilal, 2004, pp. 271–272). So, to focus solely on behaviors that need improvement is to forget these differences. On the other hand, it is also important to note some similarities with adults' information seeking. Poole (1985) found that the Principle of Least Effort was the strongest result found in his review of a dozen information-seeking studies. Specifically, "least effort" does not just mean that people choose the lazy route. Rather, they minimize the overall work associated with something, both now and anticipated in the future. Gigerenzer (1999) adds to this concept, noting that human behavior wisely follows simple principles.

To view youth information-seeking behavior as generally lacking is to overlook the new behaviors nurtured and facilitated by the digital environment and to miss the golden nuggets embedded in these studies. For example, Shenton and Dixon note that "several untaught, expedient information-seeking methods were applied" in their study (2004, p. 195). What are these methods? What can be learned from them? Children consistently have more successful results on self-generated tasks, followed by imposed research tasks, with the least success on finding specific factual information (Bilal, 2004). What does this tell us about teaching and learning? Multiple research studies find students almost universally choose browsing over planned or systematically guided searching (Large, 2004). This is generally regarded as "less desirable," but is it? Or is there somewhere in between overly structured and completely unstructured searching? And what about measures of success? Adult "experts" determine the level of success of children's searches, but how often are children involved in defining the criteria for this success (Dresang, 1999a; Bilal, 2004)? What could be learned if they were? Perhaps a new model of youth information seeking in a digital environment should be developed, incorporating these somewhat overlooked factors.

Gender Studies

A large body of recent research focuses specifically on gender in relation to information seeking and media in the digital environment. Many of the studies examine male and female behavior in relation to video games, since game playing is a top activity for youth computer use (Agosto, 2004b; Cassell & Jenkins, 1998). In a recent meta-analysis of gender and educational technologies, Agosto (2004a) concludes that gender as a sole determining factor is too simplistic a way to look at information-seeking behavior. Studies consistently used to find males were more interested and involved with technology than females; this is often no longer the case (Miller, Schweingruber, & Brandenburg, 2001; North & Noyes, 2002). Confirming this conclusion is a research project funded by the Institute for Museum and Library Services and conducted by Dresang, Gross, and Holt in the Saint Louis Public Library. *C*hildren's *A*ccess to and *U*se of *C*omputers *E*valuation (Project CATE), which appears to be the only such study set in a public library with the data disaggregated by gender. Analyzing data from 200 surveys, focus groups involving thirty-seven youth, and three week-long observations of several hundred youth in six public library locations, Dresang, Gross, and Holt (2004) found that girls and boys, ages nine to thirteen, were equally positive about computers and their ability to use them. The result of a close examination of these recent studies is a caution to avoid generic statements about gender and to realize that in the digital environment previous assumptions are not always accurate.

Radical Change and the Meta-Analyses

A trend observed about these meta-analyses is that many "research-driven assumptions" may need close reexamination in the interactivity, connectivity, and access of the digital environment. In the reconsideration of the studies focused on use in these meta-analyses, considering how the principles of interactivity, connectivity, and access could bring a new perspective to the research might increase understanding and suggest new directions for further investigations. In the sections below, Radical Change is applied to specific research findings, demonstrating how this can happen. It is obvious, of course, that the Radical Change principles of interactivity, connectivity, and access cannot be applied or examined in a mutually exclusive way, so research is discussed under the principle where it seems most fitting.

Information-Seeking Behavior and Interactivity

"Interactivity" refers to dynamic, user-controlled, nonlinear, nonsequential, complex information behavior and representation. The observations and examples below refer to the interactivity built into resources and the interactivity of the information-seeking behavior of youth as they access these resources.

Two terms, coined by Dresang (1999b) to apply to handheld, two-dimensional books, must be defined. "Handheld hypertext" refers to books that reflect the nonlinear, nonsequential characteristics of digital media, with text alone or text and graphics. "Digital design," a subset of handheld hypertext, describes the presentation of pictures and text in a juxtaposition that requires, or at least promotes, a hypertextual approach to thinking and reading.

Children's Affinity for Digitally Designed, Hypertextual Resources

In an early digital media study, Marchionini (1989) found that students' strategies in an electronic textual environment tended to be interactive and particularly well suited to digital resources. Similar findings come from research on children's use of the Web. In her overview of children's information seeking on the Web, Bilal states that "overall, children did not explore text-only sites often; preferred sites with high visual content and short, simple textual content, and liked to see more animation and interactivity on the Internet" (Bilal, 2004, p. 278).

In a study of elementary school children's use of a CD-ROM product, Large, Beheshti, and Breuleux (1998) demonstrated the children's affinity for nonlinearly presented information and their "ability to extract selectively information and to evaluate sources in terms of usefulness as well as enjoyment and ease of use" (p. 343). The authors comment that "Dresang (1997, p. 649) may well be correct in saying that 'children have demonstrated their comfort level with far more complexity than adults previously thought possible or appropriate'" (p. 369).

But until recently, no one had formally studied whether these same qualities interest children when they appear in handheld books. Several twenty-first-century studies find that handheld hypertext is as appealing to children as that in digital resources. Moreover, some of these studies conclude that the digitally designed resources promote higher-level thinking among young children rather than confusion because of their complexity.

Pantaleo (2002) has conducted research with first-grade children using digitally designed books identified by the Radical Change theory. The books she selected were nonlinear and nonsequential in organization and had interactive formats with multiple visual and verbal perspectives. From her study of children's reactions to David Wiesner's *The Three Little Pigs* (2001), in which the little pigs visually break out of their original story, Pantaleo concludes that "the Radical Change characteristics . . . described in this paper require readers to have heightened involvement in the creation of meaning" (2002, p. 81). She continues, "some individuals may think that . . . Radical Change characteristics are too difficult for children" (p. 81). However, she finds that children can handle quite sophisticated visual and narrative design. In another study Pantaleo (2004a) explores further how young children "read" nonlinear, multiple-layered texts; this time she focuses on David Macaulay's *Shortcut* (1995). Here she states that "Radical Change texts with metafictive devices can provide the kinds of reading experiences that develop readers' abilities to critically analyze, construct, and deconstruct an array of texts and representational forms that incorporate a range of linguistic, discursive, and semiotic systems" (2004a, p. 17). In her discussion of this study, she takes her findings a step further to the overlap between handheld hypertext and digital media: "Further, one can connect the kinds of skills required by web literacy with reading books with metafictive devices. . . . Web literacy . . . demands different navigational and reading strategies than traditional printed texts, and indeed, there are some similarities between the strategies and skills required for web literacy and those required for reading metafiction" (p. 17). She corroborates these findings in a third study (2004c) that uses Anthony Browne's nonlinear, multilayered picture book, *Voices in the Park* (Browne, 1998).

Hammerberg (2001) studied the reading and writing of early elementary school age children and concluded that their natural way of approaching both functions is "hypertextually." She studied texts identified by Radical Change to propose a reform of the teaching of writing. The purpose of her study was "to find the places where contemporary writing instruction can be updated to include elements of hypertextual reading, meaning beyond printed words, multiple perspectives, and complexities of plot" (p. 208). She proposes something she calls "shared and interactive writing."

While Pantaleo and Hammerberg ostensibly are studying how young children read and write, they are, in fact, observing the children's information-seeking behavior in relation to digitally designed text. Pantaleo details

how children make connections and fill in gaps to gain the "information" they seek, which is a story that makes sense to them. What Pantaleo and Hammerberg observe mirrors Cooper's advice that "in order to best support children's information-seeking needs, it is important to examine the manner in which children think about information" (2004, p. 189).

A previously unpublished pilot case study, too small to do more than tentatively suggest areas of investigation, conducted by Dresang and Chris Hart, a doctoral student at Florida State University, documented two sixth-grade students' reactions to digitally designed books. Nonfiction books from the DK Publishing Company (Pearson), a pioneer in the sound bite presentation of information, were chosen for the study. The students were videotaped on two occasions of an hour each reading the books; they were asked to "think aloud" as they read. One of the researchers also commented aloud on the information behavior he observed, and the students were interviewed after the intervention. After these laboratory sessions, the students were given a book of their choice from those selected for the experiment to take home for a week to read, and they were interviewed again about their reading of the text. Although their information seeking differed in how they approached the materials (one followed research findings in her browsing behavior, while the other followed a planned, structured approach led by the systematic DK visual presentation), they were in agreement that the digitally designed format had become essential for them. One student expressed the sentiment of both: "I am so accustomed to making choices in the information I access and in the visual guides along with words, and with words that are not all buried in huge blocks of text, that I would not have pursued the information in another more traditional format" (personal communication, April 12, 2000). The children were attracted by the high degree of interactivity required by these books and the visual guides they provide.

Implications for Research and Practice

Interactivity as identified by Radical Change is reflected in information seeking related to both handheld and digital media. Researchers studying the information behavior of children related to reading and writing have recognized the similar "literacies" that need to be developed for hypertextual media in either environment. And they are capitalizing on these similarities. Knowing that children read naturally in a nonlinear manner might explain why some aspects of Web surfing are quite easy for youth. To date, researchers of specifically digital media have not recognized this common ground or what might be learned from it. Burnett and Dresang (1999) describe this instructive overlap in their discussion of rhizomorphic reading. The information literacy found lacking in online searching might be somewhat mitigated by studies of how children read similar handheld text.

Moreover, for practicing professionals, the recognition that the "divide" between handheld books and digital media is not the gulf that is sometimes portrayed will be useful in guiding youth to think or act in a more integrated, multisource manner in their information seeking. Using digital media and handheld books interchangeably to teach searching skills might yield rewards in approaching both. Recognizing the appeal of books that reflect digital media and the "why" of the appeal might help librarians and teachers with selecting books that motivate young people to read. Many benefits might come from recognition of this "overlap" between digital media and handheld hypertext for those who can think outside normal information structures.

Information-Seeking Behavior and Connectivity

"Connectivity" refers to the sense of community or construction of social worlds that emerge from changing perspectives and expanded associations in the real world or in resources. The media in a digital environment often serves as a catalyst for connections that in turn facilitate information seeking.

The Social Nature of Youth Information Seeking: Knowing Together

Children's collaborative information behavior has been studied in relation to digital media. Druin et al.'s (2003) analysis of children's use of interfaces for a digital library under two separate collaborative conditions produced no "black and white" conclusion about the extent to which collaboration facilitates children's information seeking. Much depends on expected outcomes for the activities. A meta-analysis (Lou, Abrami, & d'Apollonia, 2001) that examined 122 studies involving 11,317 student learners using technology found that overall small group achievement exceeded that of individuals working alone. Caveats to this finding exist: without proper structure and "coaching," some individuals achieved better working independently.

Some adults have suggested that children's use of computers disassociates them from important social development (Healy, 1998). Project CATE provides an alternative view. A dominant theme that emerged from analysis of the statements made by youth in the study of their information-seeking behavior in the Saint Louis Public Library, with the assistance of NUD*IST content analysis software, was the preferred social, connected nature of information seeking (Dresang, Gross, & Thompson, 2002). Children reported both wanting to work together on the computer (despite the fact that many of them were doing different homework assignments) as well as desiring the opportunity to share information that they had found.

When asked what changes they would make in the library, many of both the boys and the girls mentioned that they would like to work at computers with one or more friends. In terms of wanting to share information, a fifth-grade boy explained, "I think they should have clubs where you

can get together and talk about . . . computer games that you like, and people can suggest good things . . . to hear ratings from other people your age" (Dresang, Gross, & Thompson, 2002, p. 23). A middle school boy articulated this sentiment: "We could share web sites with each other and different things on the computer" (Dresang, Gross, & Thompson, 2002, p. 23). Another aspect of this information-sharing behavior emerged from the desire of youth to teach others what they had learned. A fifth-grade girl suggested, "Little kids that are in kindergarten or in pre-school, they want to learn. . . You can teach them to go to those dot.coms on the computer" (Dresang, Gross, & Thompson, 2002, p. 22). The idea of "knowing together," or a community of learners on or offline stimulated by or focusing on Internet sources and activities, emerged from this data when it was looked at holistically. Moreover, young people wanted this sharing to occur as they sought the information, not only with time delay. The message was so clear that the Saint Louis Public Library changed its policy of one child per computer and allowed small groups of children to seek information together; the library also established Club Tech, a formal opportunity for youth to share this kind of information.

Some previous research, for example, an earlier study of information search styles and gender (Burdick, 1996), has indicated that boys are less likely to enjoy working in socially connected environments than girls (Bilal, 2004, pp. 280–281). This finding was not corroborated in Project CATE, where both boys and girls wanted to interact in a similar manner. In another study a group of researchers (Anderson, Hilton, & Wouden-Miller, 2003) found that young children, videotaped at various activities, played more cooperatively at the computer center than any of the other three centers provided for them.

Serendipitous Social Information Seeking Online: An Example

Little information was gleaned from the Saint Louis Public Library study about online social worlds because at the time of the study the library did not encourage chatting online and emails. Much anecdotal evidence exists, however, that youth engage in online chat and build a wide variety of social worlds as they seek information.

An example of this type of connectivity comes from sixteen-year-old Celia McGinty in Moscow, Idaho, the daughter of a police officer at Washington State University and head of a cyber crime unit. One afternoon Celia logged on to a favorite music chat room and struck up a casual conversation with a seventeen-year-old from Detroit, who identified himself as Andrew Osantowski. The casual turned serious when Andrew revealed in specific detail his plans to take violent revenge on teachers, schoolmates, and a police liaison officer at Chippewa Valley High School with assault weapons he had accumulated and a homemade bomb. Celia instantly recognized danger and reported the incident to her father. The subsequent investiga-

tion resulted in the arrest of Andrew with a $1 million bond and ten felony charges. Celia and her dad were invited to Detroit to be honored as cyber-heroes—and for Celia to talk to the teens there about the importance of detecting and reporting threats on the Internet (Officer's daughter, 2004). Celia's alert digital age information-seeking behavior required connectivity to both an online and an offline community that extended far beyond her geographic boundaries.

This is only one of numerous anecdotal instances of information-related connectivity that youth have discovered online, ranging from a gay young person in Texas finding people with whom he can freely discuss his issues and gain needed information (for the first time), to young activists in Brooklyn organizing a political demonstration, to students engaging in collaborative online projects such as *ThinkQuest* (2004), in which young people, separate geographically, produce sophisticated Web site projects with a great deal of information.

Implications for Research and Practice

The connectivity of the digital environment extends far beyond the electronic networking into the creation of communities on and offline. The social nature of information seeking that is occurring can be explained by the connectivity that permeates the digital environment, but little is known about it to date. Although researchers are examining the nature of online communities peopled largely by adults, little research seems to exist to determine what this type of connectivity does to facilitate information seeking for youth. Further research is needed to determine preferences and successes in collaborative activities using digital media, particularly when it is not "enforced," such as in public library settings, and to determine whether gender in these collaborations affects preference or success. Conditions under which collaborative learning on the computer yields greater success need to be identified. *ThinkQuest* (2004), which depends on collaborative learning, could provide a laboratory for the study of collaborative information-seeking behavior. Following the wisdom of the Saint Louis Public Library, which changed its policy in light of stated youth preference, librarians may examine how to capitalize on the social nature of knowing. Libraries should recognize different information-seeking styles just as other educators recognize different learning styles.

Information-Seeking Behavior and Access

"Access" refers to the breaking of long-standing information barriers, bringing entrée to a wide diversity of opinion and opportunity. The digital environment may facilitate or inhibit access.

Previously Unheard Voices Emerge

One of the questions that has emerged in the past decade as crucial to understanding information access and digital media for children is "What

can we learn from children?" The posing of this question in and of itself provides additional access to youth. Interest in the idea of working with young information seekers in order to give them a role in achieving the access they want and need has become an increasingly accepted practice in the digital environment. In the past, children have been among the marginalized populations (and continue to be to some extent) whose voices were seldom heard in relation to decisions that affected their information-seeking behavior. Many different levels of this type of access for children exist in the digital environment, from asking about or observing their reactions after decisions have been made (possibly to incorporate them in future planning), to questioning them casually in ways that may or may not affect decisions, to soliciting their opinions formally on a one-time or occasional basis that will affect planning at a point in time, to long-term partnering that has a direct and ongoing impact on decisions.

Children as Part of the Design Process

The bulk of studies regarding child information behavior in a digital environment focus on the child as user of information. The most recent research (and practice) incorporates the child into at least part of the design process; slowly researchers and professionals are realizing that this is the optimal way to increase access to information (Nesset & Large, 2004). Druin (2002) categorizes children's roles in the design process as user, informant, tester, and design partner chronologically as they first appeared in the research literature. In her examination of existing research, she observes that, although the needs and resources of the individual project determine which role is set for the child, the potential for greatest positive impact resides with the children as design partner, which subsumes at least part of each of the roles that preceded it chronologically.

The Project CATE inquiry into children's use of technology in a public library setting was based on information solicited from the end user—youth—both at the beginning and throughout the project (Dresang, Gross, & Holt, 2003; Gross, Dresang, & Holt, 2004). These researchers developed an outcome-based model for planning and evaluating youth services (Dresang, Gross, & Holt, in press). It differs from other such outcome models by virtue of beginning with the young people and involving them throughout the process rather than only questioning them after their information seeking has taken place.

Throughout the project, and continuing after its completion, the technology staff of the Project CATE libraries reviewed the eleven technology outcomes that were developed from the survey and focus group data. From formative and summative interviews with staff members and youth, and from observations of the youth behaviors, it became clear that youth were gaining greater access to what they wanted and needed than prior to their involvement in the process. Focus on outcomes that were youth influenced

gave staff confidence in their services and encouraged youth receptiveness to what was provided.

The Increased Array of Information

Another access issue is the availability of an increased array of information on a wider diversity of topics. The Internet Archive, which attempts to archive all publicly accessible Web pages, currently contains approximately one petabyte of data, and it grows at a rate of twenty terabytes per month. This makes the collection already larger than the amount of text contained in the world's largest libraries, including the Library of Congress (*The Internet Archive,* 2004). Any study of youth information behavior has to take into account the explosion of information (data, knowledge) that has taken place in the digital environment. Coupled with close to universal access to computers at school, library, or home for most youth, the constantly growing stockpile of information is there for the taking.

With this increase in quantity has come access to topics that previously were forbidden to youth. Greater access to topics that have been considered too controversial or not "age appropriate" has happened in the handheld book as well as in the online environment. The attempt to hide information from youth or youth from information has become a more or less futile attempt.

Issues of Dissemination Versus Access

Nonetheless, it is important to recognize the barriers that lessen that access. The Internet Archive (and active Web pages) represents dissemination of information. Due to legislation and judicial actions, for example, the Children's Internet Protection Act (CIPA, 1999), schools, including school libraries, and public libraries must place filters, limited to visual images harmful to minors but in practice not applied solely to visual images, on all computers funded by the e-rate, Library Services and Technology Act, or Title III of the Elementary and Secondary Education Act ("No Child Left Behind"). At the moment, the focus on limitation of access to information for youth appears to be on the Internet; despite the increased "radical" nature of these limitations, censorship of books, as recorded by the American Library Association, has dropped 39.8 percent over the past decade, from 762 challenges in 1995 to 458 in 2003, the most recent year reported (ALA, n.d.)

Implications for Research and Practice

Access in the digital environment creates opportunities for previously unheard voices and taboo subjects. But dissemination and access are not the same. Research is underway regarding the role children can and do play in their own information fates, and this needs to receive increased emphasis. Little or nothing is known to date about how information policies limiting youth access, specifically to digital resources on the Internet, has affected information-seeking behavior. It is an area of research that would

provide immediate and useful insights for librarians. Likewise, has the drop in challenges to books, mostly books for youth, and the publication of books on previously taboo topics for youth had any impact on information seeking in libraries?

The Future: Brain Research and Information Seeking Behavior

Another question that emerged in the past few years is "What new technologies are being developed and how can these be used as building-blocks for future applications for children?" To date, what we know about information-seeking behavior of youth and digital media comes from informed observation of performance and from what young people can tell us. In 2005 we stand on the cusp of what could someday be a significant step forward in understanding the information seeking of youth based both on observed brain structure and measured brain activity. The current discoveries of neuroscientists will lead us at some time in the future beyond the point of the information-seeking theories extrapolated only from observations of human behavior. Some of our yet-to-be-developed information-seeking theories will be based on observations of the brain itself linked to simultaneous behavior.

Magnetic resonance imaging (MRI) and Positron Emission Tomography (PET) scans have given neuroscientists the opportunity to conduct longitudinal studies of physical brain development in healthy children and adolescents. A groundbreaking study conducted by a team of researchers at the University of California at Los Angeles, Harvard, McGill University, and the National Institutes of Health (NIH), reported in the scientific journal *Nature* (Thompson et al., 2000), resulted in a feature on National Public Radio two years later and a cover story in *Time* (Wallis, 2004) two years following that. The breakthrough finding of this project, which used MRI to take "brain snapshots" of 1,800 young people over 13 years, is that the brain is not through developing by around age twelve as previously thought. This was the theory put forth by Piaget and other "step" developmental psychologists, based on observations of children's behavior. Twelve or thirteen was the age of formal operations, thought to be the highest level of cognitive attainment in terms of brain development.

The brain, according to the new and more accurate research, in fact, may not be mature until its owner is around age twenty-five. With this "look inside," scientists have observed that the last part of the brain to mature is the prefrontal cortex, home of functions such as planning, setting priorities, organizing thoughts, suppressing impulses, and problem solving (and possibly information seeking?). The cerebellum, the only part of the brain that continues growing well past the teens, supports more advanced learning activities such as mathematics, music, and more advanced social skills. It is easy to imagine how these findings may translate into a better

understanding of information-seeking behavior. Perhaps it could be the state of their brain development that affects what seems like less than stellar information-seeking behavior of youth.

But the scientists involved in this research give many caveats. One is that it is far too early to make any educational or policy decisions from the findings. Bruer (1999) and others warn that, as researchers discover more and more about the teenage brain, it is natural that parents, educators, and policy makers want to apply this new knowledge as quickly as possible in homes and classrooms. However, as an examination of the controversy over what has become known as the zero-to-three movement shows, there are potential pitfalls when advocacy groups and others prematurely attempt to apply science to public policy (Moughty, 2002). Issues that mitigate against this too-early application of findings include the lack of "system knowledge," that is, how all the parts of the brain work together, and an understanding that the brain and the mind are not the same (PBS Frontline, 2002).

Thus, mention of this research brings with it both a cautionary note (it is not time to make assumptions about information seeking yet) and an admonition (to keep a sharp eye on legitimate research in this field). It is possible that the scientific applications will give us more information about the "brain" in order to look at the behavior and get a firmer grasp on the "mind."

Conclusions

From this overview of meta-analyses followed by a theoretical look at some of the aspects of children's information-seeking behavior that can be explained by the Radical Change principles of interactivity, connectivity, and access, the following conclusions can be reached:

- An abundance of research exists on children's information-seeking behavior in the digital environment from which some overall trends can be discerned.
- Meta-analyses of the research on youth information-seeking behavior and use of digital materials tend to focus largely on the deficiencies and the need for improvement rather than ferreting out the potential of new and exciting ways of knowing in a digital age.
- New information is coming to light about specific factors, for example, gender and collaborative behavior, that may alter the interpretation and application of earlier research.
- Some important, and largely unexamined, commonalities exist between information seeking in relation to handheld hypertext and to digital materials, opening up a new arena for research and practice.
- Use of computer technology does not have to be a socially isolating activity and may, in fact, provide greater connectivity in a social environment.

- Most of the existing research focuses on children as users of digital materials, but a growing body of research highlights their roles as tester, informant, and designer, with each of these roles incorporating parts of the ones that came before it.
- Children's increased involvement in designing materials to meet their needs is relevant to their information-seeking behaviors as the outcome is accessed in ways that make sense to them.
- The digital environment has brought with it some government-mandated restrictions on children's access to digital materials in libraries, but in the balance the gain is far greater than the loss.
- Public libraries, despite legal and judicial restrictions, may provide opportunities for interactivity, connectivity, and access that are not as readily available in school or at home. In turn, researchers may learn about less-observed facets of information-seeking behavior in this currently relatively untapped setting.
- The future of brain research may be crucial in helping researchers understand the mind as it relates to information-seeking behavior.
- Looking at youth information-seeking behavior (both existing studies and new ones) with the Radical Change digital age principles of interactivity, connectivity, and access may bring new and perhaps more positive perspectives to both researchers and professionals.

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Children's Information Seeking and the Design of Digital Interfaces in the Affective Paradigm

Dania Bilal

Abstract

Research reveals that affect imparts directionality to cognition, which in turn influences actions. The role of affect has been well recognized in psychology, computing, education, cognitive science, and neuroscience. However, little recognition has been given to the study of affect in the field of information science. In this article the term "affective paradigm" is introduced based on research grounded in many disciplines. Research that investigated children's affect in seeking information and participating in the design of digital interfaces is reviewed. Unanswered questions in these areas of study are addressed.

Introduction

The fields of information-seeking behavior and computing are increasingly focusing on the role affective states play in interacting with information systems (Nahl, 2004; Druin, 2005; Bilal, 2001; Kuhlthau, 1991, 2004; Wilson, 1999; Picard, 1997). Information seeking is founded on the cognitive paradigm that ascribes the purpose of an information retrieval system as to "help solve problems rather than to merely find texts about those problems" (Raber, 2003, p. 104). Unlike the physical paradigm that focuses on how to match the content of texts in these systems with a user's query, the cognitive approach is concerned with mapping texts onto the user's anomalous state of knowledge (ASK) or knowledge structures (Raber, 2003). ASK (Belkin, Brooks, & Oddy, 1982) presumes a gap (anomaly) in a user's knowledge structure and that the motive for seeking information is to resolve this anomaly by acquiring information that changes the user's

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state of knowledge. The physical and cognitive paradigms have been acknowledged as crucial notions that underlie our understanding of the field of information science.

The cognitive paradigm focuses on the whole user's experience in seeking information, that is, thoughts, feelings, and actions (Dervin, 1983; Ingwersen, 1992; Kuhlthau, 2004; Nahl, 2004). Attention that has been given to affect in research that is grounded in psychology, cognitive science, neuroscience, computing, and education (Burleson & Picard, 2004) requires that feelings be studied in the realm of an "affective paradigm."

One may argue that, while a user's affect can be explored by using a qualitative research methodology, information retrieval systems (IRs) are not sufficiently advanced to model a user's affect during the interaction, and, therefore, the affective paradigm is incomplete. While this may be true, researchers in artificial intelligence and affective computing (Burleson & Picard, 2004; Picard, Vyzas, & Healey, 2001; Pantic & Rothkrantz, 2000) seek to develop intelligent applications that detect a user's affect while interacting with computers to help cope with negative affects. Adaptation of these applications to IRs in the near future may provide a more complete picture of the affective paradigm.

In the current information environment, children have become major consumers of information (Rothman, 2003). The Web is a rich information tool; but it is complex and may impose disorientation and cognitive overload on users (Saracevic, 1997). Since children have emotional skills and needs that vary from those of adults (Ericson, 1978; Walter, 1994; Bjorklund, 2000; Bilal & Kirby, 2002; Druin, 2005), they need to possess not only adequate information-seeking skills but also intelligent affective strategies that will help them cope with its complexity.

Theoretical Framework

Prominent theorists in the field of psychology (John Dewey, George Kelly, and Jerome Bruner) consider learning as a process of construction that engages all aspects of an individual's experience (Kuhlthau, 2004). This constructivist view of learning recognizes that affective experience directs cognition and action throughout the process of construction. Kuhlthau borrowed the theories of these constructivists to explain the user's perspectives on information seeking. Her Information Seeking Process (ISP) model describes the kind of thoughts, feelings, and actions a user experiences at each phase of the construction process. She states that negative affect such as uncertainty could lead users to be less willing to continue interacting with an information system (Kuhlthau, 1993). Nahl (2004) supports this view and contends that uncertainty could add to the "affective load," especially when a user's coping skills are inadequate.

Affective technology, affective computing, and emotional design are areas of research being investigated in the fields of computer science, human-

computer interaction, and cognitive science. In his recent book, *Emotional Design,* Norman notes that "everything [we] do has both a cognitive and an affective component—cognitive to assign meaning, affective to assign value. [We] cannot escape affect: it is always there. More important, the affective state, whether positive or negative affect, changes how we think" (2004, p. 25). He adds that, while cognition interprets and understands the world around us, emotions allow us to make quick decisions about it.

Current research conducted at the MIT Affective Computing Research Group aims at developing new computational theories of affect and learning through studying, testing, modeling, and giving computers the ability to recognize common affective states expressed by users while interacting with computers (for example, frustration, confusion, fear, distress, or joy). The MIT approach is grounded in the findings from cognitive science, psychology, neuroscience, medicine, psychophysiology, sociology, and ethics (Picard, 1997). Burleson and Picard (2004), who are on the MIT Group, for example, have applied affective agents to help users develop skills such as affective self-awareness for dealing with failure and frustration while interacting with computers.

An individual's emotional experience has been a primary topic of study throughout most of the history of psychology. Erikson's (1978) development theory, the "Eight Stages of Man," covers the socioemotional stages an individual experiences during an entire lifespan, from infancy to older adulthood. Krathwohl, Bloom, and Masia (1999) developed a taxonomy with six educational objectives in the affective domain that focus on a student's level of commitment (receiving, responding, valuing, organizing, and valuing).

Recently, emotional intelligence and affective education have been recognized as integral to learning. Steinberg (1998) acknowledges a child's cognitive and affective skills in the classroom and that learning takes place in an "emotionally safe" environment. Goleman's (1997) emotional intelligence notion dismisses IQ as the only predictor of achievement and grounds emotional skills as essential for success. He contends that, through the application of intelligence to emotion, we can improve and gain control of our lives. Indeed, recent research has revealed that learning to cope with information overload helped users reduce uncertainty and frustration (Nahl, 2004).

The Status of Research

Compared to the literature devoted to adult users, the body of literature on both children's use of the Web and interface design for children is very small. From this literature investigators have focused on the cognitive behavior and alluded to one or two affective factors expressed by users such as preferences, satisfaction, frustration, and joy (Bilal & Wang, 2005; Shenton & Dixon, 2003; Large & Beheshti, 2000; Sullivan, Norris, Peet,

& Soloway, 2000; Hirsh, 1999; Kafai & Bates, 1997). According to Picard (1997), common factors that computer users experience include confusion, frustration, dislike, like, joy, satisfaction, motivation, and preference. The section below reviews studies that examined the impact of these and additional factors on children's information seeking on the Web.

Children's Information Seeking on the Web in the Affective Paradigm

Watson (1998) analyzed stories from nine eighth-grade students about using the Web and extracted common themes about the students' feelings and perceptions. A sense of self-confidence and authority in using the Web emerged from both having experience with using the technology and learning by "trial and error." Joy and challenge in finding information and the need for patience and persistence surfaced as motivational factors. Additional factors that influenced the students' affect were ease of access, finding information quickly, grandness of the Web, and ability to browse and search. Watson's study provides interesting dimensions of these young users' thoughts and feelings by relying on their stories. However, examination of the students' affective states during Web interaction may provide a more complete picture of the "actual" interaction between their thoughts and feelings and, subsequently, will help generate a framework for both educators and information professionals to use in designing curricula and Web training programs. Moreover, a student's willingness to engage in a "trial and error" learning experience may offer educators and curriculum designers new ideas for pedagogy since this mode of learning may challenge the systematic approach to accessing information.

In studies that examined middle school children's information seeking in using the Yahooligans! Web engine/directory, Bilal (2000, 2001, 2002a) explored these young peoples' affective, cognitive, and physical behaviors in performing three tasks: one fact-based (Bilal, 2000), one research-based (Bilal, 2001), and one fully self-generated (Bilal, 2002a). Children's affective states were captured through individual interviews that covered questions about these factors: joy of using the Web, frustration, confusion, motivation, persistence and patience, task preference, source preference (for example, Internet vs. print sources), and search engine preference. These studies revealed an interaction between children's affective states and cognition and actions. The affective results of these studies are reported below. For results concerning the cognitive and physical behaviors, the reader is referred to Bilal (2000, 2001, 2002a).

Joy of Using Yahooligans!

What did the children enjoy about using Yahooligans!? Most children (87 percent) referred to ease of use over print sources, ability to search by keyword, learning about the topic searched, grandness of information on

the Web, availability of graphics, convenience of access, and fun. These comments were echoed in statements that children shared: "Easy to find information . . . Type a word and takes you to a site . . . Click on information to find it . . . I found information on ice skating, [my] personal topic . . . [I think] information is interesting . . . [I enjoyed] information and pictures . . . I've never searched Yahooligans! Searching new things is neat to me." The child who did not enjoy using Yahooligans! was scared of computers. Overall, joy and motivation of using the Web increased children's persistence and patience in finding information despite the difficulties and breakdowns they had experienced due to both insufficient Web skills and the inadequate interface design of Yahooligans!.

Frustration and Confusion

Frustration arose when children retrieved zero hits and when they did not find relevant information. Forty-three percent felt frustrated during the search process. Of these, 5 percent were uncertain about their ability to use Yahooligans!, and 10 percent did not find the answer to the fact-based task or locate relevant information on the research-based task. As children shared: [I am] "confused because it said it would find information but didn't . . . Because [I] never used it . . . First I was confused during searching because I couldn't find the answer. [It] got better when I did my personal search . . . You look for information and it doesn't give it to you." Feeling frustrated was also expressed for slow download of Web sites, screen freezing, and confusing screen display. At the time of data collection (1998), Yahooligans! was slow and the Netscape browser used was version 2.0. The fact that the browser froze frequently increased children's frustration and uncertainty. In addition, the organization of the retrieved results (categories and sites within categories) was confusing to a few children. Despite these difficulties, no child abandoned his or her Web session. At the time of the study, the Internet was a novelty to many children at the middle school. The fact that children had the opportunity to use the Internet increased their resiliency in pursuing the tasks.

Motivation

Most children (85 percent) were motivated to use the Web for many reasons: increase in self-confidence, challenge, discovery, and convenience. As a few children said: "I could do it because I didn't think I could do it" (self-confidence); [I learned] "something I did not know before on topics I'm interested in" (discovery); [it is] "still new to me and gives me something different," "got to use the computer, go to different places for fun, [and you] find study you don't know about" (challenge and discovery); [I can] "use the Internet from home . . . most people have Internet in their homes . . . there are so many sites and instead of driving to the library you get on the Internet at home . . . [The] Internet is growing fast . . . all things you can learn . . . tells more than encyclopedia" (convenience); and [it provides]

"games and more information . . . doesn't take long . . . All in one place . . . chat, email, finding information for projects, and downloading information on projects" (fun, grandness of information, and convenience). Lack of motivation was expressed due to being scared of using computers, difficulty in finding information, and unfamiliarity with Yahooligans! These findings should provide grounds for future research that measures children's level of positive and negative affect systematically throughout the information-seeking process.

Persistence and Patience

Children's motivation in using Yahooligans! augmented their persistence and patience in locating the desired information. They expressed that, unlike print sources, the Web supported exploration and discovery and provided comfort and convenience. These comments were reflected in these statements: [I] "know the answer is there and I know I'll probably get the information eventually . . . It's got to be there, so I keep trying . . . Knowing that I'll probably get the information eventually . . . [I] don't have to read words all the time . . . [I] wouldn't persist in encyclopedia use." Indeed, most children (65 percent) preferred using the Web to print sources. The second favorite source was encyclopedias (by 15 percent), followed by books (5 percent), a combination of the Internet and encyclopedias (5 percent), encyclopedias and books (5 percent), and Internet and books (5 percent). A recent study by America Online (Rothman, 2003) revealed that the Internet has remained children's primary source for educational and entertainment information.

Search Engine Preference

At the time of data collection (1998), Yahoo, Excite, WebCrawler, and Infoseek were the most popular search engines. Twenty percent favored Yahoo, while 15 percent preferred Netscape. One child (5 percent) mentioned America Online and two children (10 percent) said Prodigy. WebCrawler and Excite were each mentioned by 10 percent of the children. Interestingly, one child (5 percent) noted the Web site of the University of Tennessee. The fact that not all children recognized the difference between a search engine and a browser, a service provider, or an institution's Web site indicated inadequate knowledge of how to use the Web. Children's search engine preferences may have changed with the advent of search engines such as Google. A recent study (Bilal, 2003) showed that children preferred search engines that are designed for adult users such as Google, Alta Vista, AskJeeves, and Yahoo. The fact that these young users preferred search engines that are not geared toward their age level may be due to either unfamiliarity with them or that those engines designed for them do not meet their needs. When search engines do not offer high usability, kids go elsewhere (Neilsen, 2002).

Task Preference

Prior research revealed that, when children choose their own topics, they develop interest and tend to be more motivated in seeking information (Gross, 1997). Children were given tasks in two categories: fully assigned and fully self-generated. The tasks from the former category were closed (fact-based) and open-ended (research), and the task from the latter category entailed finding information on a topic of interest. Of the children who articulated their task preference, 45 percent favored the fully self-generated task, 20 percent the research task, and another 20 percent the fact-based task. One child (5 percent) liked all three tasks and another one (5 percent) was unsure. Overall, children preferred the fully self-generated task for three reasons: satisfaction with search results, ability to choose the topics and modify them during searching, and challenge in finding information about a topic of interest. As one child shared: [I liked the personal search] "because I wanted to figure out for myself that I can use it [the Web] and use it well."

Children were positive about their experience with the Web mainly due to challenge, motivation, and increase in self-confidence. These positive affects are encouraging especially in light of the many difficulties children experienced. Yahooligans!'s inadequate design (for example, lack of spell-checking techniques, absence of corrective feedback mechanism, small database size, and scanty indexing) was at the crux of the problems children experienced. These findings are surprising especially since this engine/directory is specifically developed for young users. Like many IRs that were developed for children, Yahooligans!'s failure to meet children's needs and support their information seeking have led many researchers to design interfaces from children's perspectives by involving them in the design process. The following section describes research that explored children's cognitive and affective needs for design features that digital interfaces should provide for them.

Children and Affective System Design

The notion of "emotional design" has recently emerged as an essential component of system design. Norman notes that "attractive things make people feel good, which in turn make them think more creatively" (2004, p. 19). Emotions, which are a component of affective states, are "personal," and creating system interfaces for children should be based on their affect for them. It is argued that successful interfaces for children are those that are designed for them and with them. Children are capable of being design partners and can be considered as equal stakeholders in the design of new technologies (Druin, 2005, 1999; Druin, et al., 2003).

Gathering children's likes and dislikes about certain interface features may serve as a first step toward designing affective interfaces for them.

Large, Beheshti, and Rahman (2002) obtained the reactions of children aged between ten and thirteen using four Web portals that are especially designed for their age group: Yahooligans!, AskJeeves for Kids, KidsClick!, and Lycos Zone. Children expressed their feelings about each portal and provided suggestions for improvements. Children's needs were combined into four categories: portal goals, visual design, information architecture, and personalization. Children need a portal that provides both educational and entertainment topics. The latter seemed to increase their motivation in seeking information. In the children's eyes, the visual design of a successful portal is one with a fun name, colorful backgrounds and foregrounds, large fonts, graphics and animation, recognizable characters, suitable vocabulary, well-laid-out screens, and no advertisements. Children preferred a portal with information architecture that offered directness (little effort to search quickly), a combination of keyword and natural language searching, browsing through subject hierarchies, metasearch links (link to external search engines), display of retrieved information with informative summaries of the content, and spell-checking techniques. Based on these findings, the researchers have developed two Web portals for elementary school children that are informed by children's affective and cognitive states (Large, Beheshti, Nesset, & Bowler, 2004).

Involving children as design partners moves system design one step further. In collaborating with middle school children, Bilal (2002b, 2003) gathered eleven drawings or prototype interfaces that children designed for Web search engines. Using paper, pencil, and crayons, children created interfaces with features that met their needs. Analysis of these interfaces showed that color was used to either label text or highlight some features. The drawings equally illustrated children's need for searching and browsing by subject category. Keyword and phrase searching had explicit instructions on how to perform each of the functions (for example, type a question here, go get it). Children expressed the need for subject categories that covered both educational and entertainment topics. The *Help* feature was shown on five drawings, and on two of these it appeared twice, once in the upper-left-hand corner and another time in the lower-right-hand corner. On average, a child's interface had fifteen features.

The interfaces combined simple and sophisticated design. Simple design included the name of the engine, a search box, and subject categories. Sophisticated design entailed additional features such as two search boxes, one for keyword and another for natural language; instructions on how to perform a search; links to external search engines; and extensive broad and specific subject categories. Children's drawings were combined into three main categories: goals, functionality, and visual design.

Goals: All drawings had educational and entertainment information, indicating that children wanted to use the engines to find information for schoolwork as well as play games, chat with friends and family, listen

to music, and initiate email communication. Entertainment information seemed to motivate the children in using the engine.

Functionality: The importance of keyword searching and natural language searching was evident in all interfaces as search boxes for both features were included on most of them. Specific instructions on how to perform a keyword or phrase search (for example, click here, search, type a phrase) were covered on most drawings. In addition, children desired subject categories for browsing by broad and narrower topics. Fifty percent of the drawings showed the need for a *Help* feature.

Visual design: Children cared for text written in black and white and for color around search features. Four drawings had images such as kids holding hands and self-portraits. The names of the engines were based on the children's names (for example, Catlin.com; KidsSearch.com). These children had affects for personalizing the interfaces.

These children were effective in designing interfaces for Web search engines from their own perspectives. The next step is to generate a workable interface that builds on children's affective and cognitive developmental abilities and to test it with children in various settings.

Affective design has been acknowledged by researchers in the field of human-computer interaction. One project in this area is the International Children's Digital Library (ICDL), which was developed with children and for children. The ICDL (http://www.icdlbooks.org) offers books in multiple languages worldwide and enables children to access and read an international collection of children's books online. The ICDL has categories of books by subject, genre, publication date, characters, color, shape, and, most importantly, feelings (Reuter & Druin, 2004). The *feelings* category is based on children's need to find books by how they make children feel (for example, happy, scared, sad). The success of the ICDL design is attributed to its interfaces, which are informed by children's feelings and thoughts. Future applications for the ICDL could include intelligent agents that detect children's emotions to assist them in coping with negative affects they may experience while interacting with certain books.

Discussion

This article introduced the term "affective paradigm" based on research grounded in computing, cognitive science, education, psychology, and information science. Many disciplines have recognized the crucial role of affect on cognition and actions. However, little recognition has been given to the study of affect in the field of information science, especially as it pertains to children.

Information seeking is a dynamic process that involves the whole individual. Affect imparts directionality to problem solving, which in turn influences actions. This triad of feelings, thoughts, and actions forms, according to Nahl (1996, 2001), a conceptual framework that will drive us

into the "user-centered revolution." This revolution, however, requires that we advance our knowledge of affective system design so that we can implement intelligent applications in the affective domain. Fortunately, current research in affective computing promises new advances in this area of study that may impact the design of IRs in the near future.

There are a few models of information seeking that integrate a user's feelings, thoughts, and actions. Kuhlthau's ISP model (1993), for example, describes a user's affective states at each stage of the information-seeking process. Given that this model was based on a series of studies that were conducted with college students, and given that children have emotional experiences and needs that vary from those of adults, it is possible that the ISP model does not pertain to young users and that a new model is needed.

Many questions remain to be addressed in the affective paradigm. Are children more successful in using systems that are designed from their perspectives than systems that are not? How does a user's affect influence the interaction with affective features available in an interface? What applications are needed to address children's affective states in IRs?

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Teens Are from Neptune, Librarians Are from Pluto: An Analysis of Online Reference Transactions

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Abstract

As part of a project to evaluate the effectiveness of Tutor.com's Live Homework Help service, the authors examined over 100 transcripts of online transactions between teens and the virtual reference librarians in California who connect students to Live Homework Help tutors. Using content analysis, the authors document and discuss the difference in online communication styles between teens and adults. In addition, the transactions are measured against Reference and User Services Association's (RUSA) reference performance guidelines and are found to be severely lacking in the qualities required for effective reference service. Recommendations are made within the context of positive library service to young adults, including recommendations on how to make virtual reference encounters with teens more responsive to their homework needs.

Introduction

In 1992 family therapist John Gray published the self-help book *Men Are from Mars, Women Are from Venus: The Classic Guide to Understanding the Opposite Sex*. The cover of the 2004 paperback edition claims that more than fourteen million copies have been sold (Gray, 2004). The title has become a watchword for the seemingly galactic gaps in communication that can occur when people with different values and worldviews try to have a dialogue. The authors of this article were reminded of that watchword when they were charged with evaluating Live Homework Help, an online tutoring program funded by the California State Library. The service originally provided access to Tutor.com at designated hours at thirty libraries throughout the state. In 2003 the service was expanded to allow students

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to access the tutoring assistance program from their home computers by connecting through the state's 24/7 online reference service. We have analyzed 114 transcripts of transactions between teens and the 24/7 librarians. In this article we focus primarily on the communication gap that we discovered between the librarians and the teens. We situate our discussion within the overall context of library service to young adults. Within that context, we analyze the transactions using two different frameworks: the guidelines for effective reference performance and the basic tenets of critical discourse analysis.

Public Library Service to Young Adults

While teens are heavy users of public libraries, they are still relatively unrecognized as a specialized target market. A 1995 report from the National Center for Education Statistics reported that only 11 percent of all public libraries in the United States employ a young adult librarian, a figure that had not changed since the 1980s (U.S. Department of Education, 1995, p. iii). Librarians who do serve teens, however, are strong advocates for their clients. Through their involvement with the Young Adult Library Services Association, they draw strength from their peers and lobby the larger library field for more attention.

Current notions of good practice in public library service to young adults are based on the principles of youth development. Patrick Jones describes this approach in *New Directions for Library Service to Young Adults* (2002) as a means for supporting teens as they move from childhood to adulthood. This document, bearing the imprimatur of the Young Adult Library Services Association, includes a checklist of services that libraries might provide to achieve the mission of positive youth development. The first item on this checklist is "Develops and offers reference and information services for young adults which provide a positive experience for the customer" (p. 63).

Youth development is also the centerpiece of Walter and Meyers's (2003) vision of effective young adult library services . They present six developmental outcomes that teens need to make a successful transition to their adult years:

- Contribute to their community
- Feel safe in their environment
- Have meaningful relationships with adults and peers
- Achieve educational success
- Develop marketable skills.
- Develop personal and social skills (Walter and Meyers, 2003, p. 44)

This focus on youth development may be more normative than actual, however. It is operationalized in most instances through the mechanism of youth participation, usually through youth advisory councils of various

sorts. In practice, young adults are served largely through the traditional mechanisms of reference and reading promotion.

There is some evidence that, if teens could design their own library services, they would put less emphasis on these traditional services in favor of more homework assistance and improved access to the Internet. A small study conducted in the state of Florida ranked the strategies that are most effective in attracting teens to libraries. Both the young adults and librarians agreed that the top three priorities were Internet access, volunteer opportunities, and school-related research (Bishop & Bauer, 2002). As part of a project for the Public Libraries as Partners in Youth Development initiative, Meyers also found that teens want libraries to offer more access to technology, longer hours, fewer restrictive rules and fees, and more help with homework projects and research (Meyers, 1999).

Linda Braun has been a particularly convincing advocate for the development of relevant library-based Internet services for teens. She observes a gap between the Internet services that young adults want and need and those provided by libraries. In particular, she finds that libraries have been slow to give teens access to the online chat and instant messaging media that they find so appealing (Braun, 2002, p. vii).

Homework Assistance

Homework has been defined as "tasks assigned to students by schoolteachers that are meant to be carried out during non-school hours" (Cooper & Valentine, 2001, p. 145). Teachers assign homework for various reasons, including: (1) to encourage students to practice skills or expound on concepts learned in class; (2) to prepare for the next lesson or class discussion; (3) to foster the student's personal development through increased responsibility, time management, self-confidence, and sense of accomplishment; (4) to promote communication within the family; (5) to promote parent-teacher communication; (6) to enhance peer interactions through group study; and (7) as punishment (Cosden et al., 2001; Epstein & Van Voorhis, 2001; Warton, 2001). Although educators agree that punishment is not necessarily a valid reason for assigning work, the students themselves may consider homework a punitive exercise if their assignments are confusing or poorly constructed (Epstein & Van Voorhis, 2001). As one researcher noted, parents and teachers alike cite class assignments "as a source of considerable difficulty and conflict at home and school," often leading to student frustration, procrastination, and noncompliance (Warton, 2001, p. 155). Not surprisingly, a majority of young adults recently surveyed by Teenage Research Unlimited indicated that homework was among their least favorite school-related activities (cited in Zollo, 1999, p. 279).

A large majority of the reference questions asked by kids are homework based. Helping students with their homework often has a profound impact on library services and may be the source of much staff frustration (Gross,

2000). In the early 1990s Sager asked several administrators to define the public library's role in facilitating education. No consensus emerged, although one director adamantly advised that it "would be a grave mistake to assign an additional mission to the public library, specifically one in education . . . [as] we most likely would end-up with an institution that would do two jobs inadequately instead of one barely adequately" (Sager, 1992, p. 15). Sager subsequently described the rift between libraries and schools as a "blackboard curtain" that prevents librarians from fully serving K–12 students (Sager, 1997, p. 23).

There is evidence that librarians treat school assignments as "second-class" reference questions and that students are, intentionally or not, made to feel alienated when using the library. College students have classified librarians as "those who like to point, those who like to help, and those who hate kids" (Gross, 2000, p. 14). The teens interviewed by Meyers confirm this stereotype, saying that librarians "always have something better to do" than help students (Meyers, 1999, p. 44).

Not all librarians ignore the needs of students, however. Around the country many public libraries have begun offering formal homework assistance after school, in the evening, or during the weekend. Preliminary research has shown that this type of service results in positive outcomes (Mediavilla, 2001). In a study sponsored by the American Library Association, Walter and Mediavilla discovered that teens receiving homework help in public libraries not only achieve educational success; they may also develop important social skills by interacting with classmates and adult homework helpers. In addition, the students acquire math and computer skills that may some day be marketable in the workplace (Walter & Mediavilla, 2003).

In 1999 one out of every seven public libraries surveyed by the American Library Association delivered some form of after-school homework assistance, ranging from telephone hotlines to formal tutoring programs (American Library Association, 1999). A more recent survey conducted in New Jersey revealed that nearly 32 percent of public libraries statewide provided homework help specifically to teens. As investigators Winston and Paone noted, however, there are "a number of opportunities for enhancing service provision in this area" (2001, p. 50).

Virtual Reference

Reference services, in general, and homework assistance, in particular, took a dramatic turn in the late-1990s with the exploding popularity of the Internet. In 1998 an Ohio public library trustee asked a random sample of people what source they used first when seeking information. Twenty-four percent listed the library, while 23 percent answered that the Internet was their first choice for information. When the trustee repeated the study two years later, 36 percent of the respondents said they preferred the Internet as their primary information source, while only 12 percent said they went

first to the library (cited in Coffman, 2003, p. 6). During the same period, researchers noted a 44 percent increase in homework questions asked of digital reference services, such as KidsConnect, Ask Dr. Math, Ask a NASA Scientist, and Ask Professor Construction (Lankes, 2003).

Recognizing their patrons' reliance on the Internet, librarians began offering virtual reference services via email in the mid-1990s. Questions were received electronically, usually by way of an "Ask the Librarian" link from the library's home page. Several hours later, an answer would be delivered to the patron through email. Although revolutionary at the time, the process was clunky at best, with patrons having to wait for responses that were very one-sided based on the librarian's interpretation of the initial question (Coffman, 2003).

Eventually, emailed transactions gave way to live, synchronous "chat reference," which Francoeur defines as a service "where the core of communication between librarian and user is an exchange of text messages sent in real-time" (2001, p. 190). The advantages of such service include interactivity, anonymity, speed of response, and the ability for the librarian and patron to co-browse the Internet together (Janes, 2002; Fagan & Desai, 2003; Kresh, 2003; and Coffman, 2003). Janes also admits that virtual reference is "cool." As he suggests, "Synchronous technologies may appeal to groups of users we don't currently serve well, particularly the young, who are addicted to the social nature of instant messaging and chat technologies" (Janes, 2002, p. 13).

Although much has been written about college students using chat reference for homework and research assistance (see, for example, Blank, 2003; Broughton, 2003; and Dunn & Morgan, 2003), few articles have addressed adolescents' use of similar services. Instead, the literature has focused on the "best practices" of the few public libraries that offer in-house computerized homework centers for teens (for example, Mondowney, 1996; Sternin, 1998; Denny, 2000; and Gorman, 2002) or that have created Web portals to online homework sites (Bryan, 2002). Morris County Library in New Jersey developed a homework chat service for school kids in 2001, but it failed after only three months due to students' lack of interest (Weissman, 2001).

Linking Homework Assistance with Virtual Reference

In 2001 Tutor.com introduced Live Homework Help, an online, interactive homework assistance program that connects fourth–twelfth graders to tutors via the Internet. Synchronous homework help is provided on several topics by subject experts who are also certified teachers, college professors, graduate students, and professional tutors (Kohn, 2003). Teens appreciate the service because it is anonymous, immediate, and personalized (Gerhardt, 2004).

Nearly 600 libraries nationwide subscribe to Live Homework Help, including those in Brooklyn, San Diego County, Prince George County, and

San Francisco (Tutor.com, 2004). In California the Live Homework Help program is provided by the California State Library, which funds the project through federal Library Services and Technology Act monies (Minkel, 2002). Statewide service was also recently adopted in Alaska, Colorado, and Ohio (Statewide VR, 2004).

Because of the expense, few California libraries subscribe directly to Live Homework Help. Therefore, most California students who want to connect to the service from their homes must do so through the state's virtual reference service, called AskNow. Although many students ask to be connected to Live Homework Help as soon as they log onto AskNow, many others must first interact with a virtual librarian before being referred to a tutor. This interaction, which may or may not be successful in identifying the student's true information need, is the subject of this study.

Methodology

The advantages of using transcripts as a means of assessing virtual reference transactions have been touted by Whitlach (2001), Fagan and Desai (2003), and Coffman (2003). As Ward enthusiastically reports, "every single online reference interview can be captured in its entirety for later examination," enabling "routine analysis of the interview in ways not previously available through traditional means" (2003, p. 46).

To tease out the librarian behaviors that helped or hindered student access to online homework assistance, we examined 114 transcripts from the virtual reference sessions that ended in referrals to Live Homework Help between October 12 and November 8, 2003. One hundred fifteen transcripts were provided by the Metropolitan Cooperative Library System, which at the time oversaw the AskNow virtual reference service in California. One transcript was discarded because the transaction was obliterated by an "administrative failure" message.

Applying the Tenets of Model Reference Behavior

We conducted two successive analyses of the transcripts. First, each transcript was measured against a "Virtual Reference Behavior Checklist" that attempted to capture the various behaviors required for conducting a successful reference interview. The checklist, loosely modeled on the form developed by Gers and Seward (1985, p. 34), was based on the tenets outlined in the Reference and User Services Association's (RUSA) "Guidelines for Behavioral Performance of Reference and Information Service Providers" (RUSA, 2004). These guidelines, which were recently revised to include standards for "remote" (that is, virtual) reference transactions, address behaviors related to approachability, interest (for example, clarification and keeping the patron informed), listening and inquiring (for example, probing, paraphrasing, and communicating clearly), searching (for example, explaining the search strategy, finding the appropriate mate-

Table 1. Types of Questions Asked by Subject

Subject of Request	Number of Queries
Math	40
Social Studies/History/Civics	9
Science	8
English Composition and Grammar	7
French	2
Nondescript Subject	2
Direct Requests for Tutor	46

Note: The total number of queries in the sample is 114.

rial, and making appropriate referrals), and follow-up (for example, asking if further information is needed and/or if the question has been answered). Demonstration of these behaviors was ranked as "strong evidence," "evidence," "no evidence," or "not applicable." (See the Appendix, p. 227.)

The checklist also incorporated behaviors described by Gross (2000) as being unique to homework transactions—for example, helping the student interpret the homework question, verifying a mutual understanding of the question, encouraging the student to solve the homework problem, advising on alternative solutions and methods, and reassuring the student. In addition, we made note of the general subject (for example, math, social studies, etc.) of each homework question, as well as the length of each transaction. Particular attention was paid to how long the student had to wait for the chat session to begin.

Of the 114 referrals made by the 24/7 librarians, 40 percent (46 referrals) were made as a direct result of students requesting either a tutor, Live Homework Help, or "the website for tutors." All other patrons represented their queries as reference questions, only to be eventually referred to Live Homework Help after the librarian surmised that a tutor was needed. A great majority (60 percent) of the homework queries were math problems, while only 8 percent were science related. Nine students needed help with social studies/history/civics questions, seven had English composition and grammar problems, and two presented French language questions (see Table 1).

The 24/7 encounters were as short as one minute and as long as an hour, with the average session lasting eleven minutes. A majority of the transactions lasted seven minutes or less. Longer sessions resulted when librarians were busy, causing patrons to wait for assistance. Waiting for seven to twenty minutes to be connected to a librarian was not uncommon, with one unfortunate student having to wait forty minutes before his query was handled.

Although some librarians conducted thorough interviews and even referred the students to math or other suitable Web sites, for the most part the encounters were brief and heavily one-sided as patrons were quickly—and

Table 2. Virtual Reference Behaviors

Characteristics of Virtual Librarians	Strong Evidence	Evidence	No Evidence	N/A
Is available quickly		78	36	
Gives friendly greeting		92	22	
Encourages student to ask question		15	98	1
Repeats question/paraphrases		6	104	4
Clarifies question				
Probes for further information	3	33	75	3
Helps interpret question		2	109	3
Verifies mutual understanding			111	3
Finds an answer in source		6	8	100
Uses other sources	1	14	3	96
Communicates clearly		110	1	3
Checks that information is clearly understood	1	20	87	6
Keeps student informed		13	6	95
Offers referral		89	10	15
Encourages student to solve problem		4	3	107
Advises on alternative solutions/methods		2	2	110
Reassures student		3	107	4
Asks if question has been answered			110	4
Asks if student needs more information		10	100	4

Note: Figures indicate number of occurrences each behavior was observed in the study.

sometimes inappropriately—referred to Live Homework Help. Even worse, the referrals were often made without consulting the patron first, causing some students to express confusion when suddenly confronted by the Live Homework Help Web page. Very few of the librarians clarified or confirmed their understanding of the question and only two librarians helped the student interpret the homework assignment. Almost all librarians communicated clearly, but several (twenty-two) failed to give a friendly greeting when first encountering the patron. Only 32 percent of the librarians probed the students for more information when deciding how to proceed with the question. Even fewer (17 percent) bothered to check if the patron understood the information provided (see Table 2).

Applying Principles of Critical Discourse Analysis

Discourse analysis is generally understood to be a method for looking at language used in particular contexts as a form of social practice (Fairclough, 1995, p. 7). It studies talk or communication as a means for producing knowledge or meaning in concrete situations or institutions and aims to clarify the perspectives and points of view on which that knowledge and meaning is produced (Talja, 1999, pp. 460–461). Frohman (1994) has utilized Foucaultian discourse analysis to examine ways in which information, its uses, and its users are discursively constructed. Budd and Raber (1996) have also argued that discourse analysis is a particularly appropriate methodology for library and information science research because of its

grounding in communication and its utility in examining both written and spoken texts. They have used this method to look at the social, political, and technical uses of the word "information" and their implications for theory and practice. By applying the lens of discourse analysis, we observed two significant phenomena that further contribute to our understanding of the online transactions between teens and librarians: the negotiation of power relations and the communication of nonverbal messages.

Negotiating Power Relations Online Fairclough's approach to discourse analysis is grounded in critical studies and seeks to understand how language reveals and/or maintains the power relations in social situations. He describes the ways in which people develop what he calls "discursive conventions" that embody certain ideologies or roles. The examples he gives include the language of medical consultations and crime reports (Fairclough, 1995, p. 94). We see examples of these discursive conventions in typical reference interviews. Some of these conventions, as noted in the previous section, are intended by librarians to routinize or standardize good practices in reference work. By asking the patron, "Did I fully and completely answer your question?" for example, the librarian is requesting feedback from the patron and trying to ensure a satisfactory conclusion to the reference transaction. Fairclough points out, however, that these conventions, used by most professionals in their interactions with clients, also serve to reinforce the professional's superior position vis-à-vis the help-seeker. The formal language of the professional is a distinct contrast to the more informal and less precise language of the client. He notes that in some situations the less privileged participant in such discourse situations will struggle to replace those discourse conventions with other devices that feel more comfortable to them. We observed this phenomenon over and over again in the online transactions between librarians and teens seeking access to homework assistance.

In almost every instance, the librarians made no attempt to transcend the impersonal anonymity that the chat reference situation makes possible. They relied on the stock phrases that their pull-down menus allow them to make at the press of a button:

- "We are experiencing a very busy time right now."
- "I am going to send you a page which will give you some help with your homework. After we disconnect this session, click on this link and follow the instructions to be connected with a tutor. Please do not click on any links on this page until after we have disconnected."
- "We answer questions in the order that we receive them, and we need to finish helping the people who logged in before you. If you will continue holding, we will help you as soon as we can. If you would like us to email you with a response, please type this information: 1) Your email address, 2) Your deadline, and 3) Anything else that will help us in our search."

The teens who were trying to connect—both electronically and personally—with the librarians often did not realize that they were receiving a canned response. One teen responded to the last message above, "ok! Sorry." Another student wrote back, "take your time," followed by the ubiquitous smiley emoticon.

Some teens, almost certainly repeat users of Live Homework Help, were as businesslike as the librarians in their interaction. They would begin the transaction with a quick request to connect with a tutor. These students were familiar with the necessary online protocol and had downloaded the software needed to access the Tutor.com site. Here the automatic responses from the librarians were effective, as long as there was not a problem with the electronic connection.

In many cases, however, the student just started out with a question. Then it took longer for the librarian and student to sort out their roles and responsibilities. In a few cases, the teen did not know that he had reached a librarian. "Oh, I thought you were a tutor," one replied when the librarian offered to connect him with Live Homework Help. If the question dealt with math, the librarian in almost every case referred the student immediately to the tutoring service rather than dealing with it as a reference question. In a few cases, however, the librarian began by offering reference assistance using the Web-based resources on which online reference service depends. A look at one session of this nature is instructive for what it tells us about the librarian's perception of her professional role and her strategies for maintaining it. In the interests of readability, some of the grammar has been cleaned up, but the spelling and punctuation have been left intact.

> Student: I just need help finding some links to science fair projects. [smiley]
>
> Librarian: Hello. We are experiencing a very busy time right now. What grade are you in, so I can find out what kind of links to send you. Do you need links to help you find a project? Or links to info about a specific project.
>
> Student: i.e. want to find something about plants. [smiley] I am in 7th grade.
>
> Librarian: Ok. I will look.
>
> Student: take your time [smiley]
>
> Librarian: Hi [student's name]: I am sending you a list of science fair pages. [Item sent.] Please look through this and let me know if they help.
>
> Student: okay
>
> [Four additional web pages are transmitted, one on science fairs, one on search strategies, one on plants, and one on photosynthesis.]
>
> Librarian: Is this helping?
>
> Student: uh . . .
>
> [One more web page on photosynthesis sent]
>
> Student: can you help me find something, or ANYTHING about plants
>
> Librarian: It isn't helping?

Student: [frowney]

Librarian: Are you looking for science fair projects you can do with plants? Here is a list about plants. [Item sent.]

Student: uh . . . I just need help on finding something like . . . "does pressure affect the way how leaves grow." I don't know . . . something like that. Aaa! My project is due on Monday!!, well, not the project, the IDEA of the project, and I must write 9 pages about it. [frowney]

Librarian: Did that list I just sent help? [2 items sent] Would you like to speak to a tutor? I think a tutor would be better able to help you. I am a librarian. [Sends link to Live Homework Help.] I am going to send you a page which will give you some help with your homework. After we disconnect this session, click on this link and follow the instructions to be connected with a tutor. Please do not click on any links on this page until after we have disconnected. [Student's name.] Can you see the tutor site?

Student: ? okay. Well . . . thanks anyways [smiley]

Librarian: I just sent you a site to connect to a tutor. Here it is again. [Sends URL.]

Student: ?

Librarian: [Sends URL for the third time.]

Student: I don't see it. [frowney]

Librarian: I just sent it in our conversation too. You can open it up in another browser window. Do you know how to do that? [Student's name?] [Student's name], it looks like we have been disconnected.

Now, this is actually a very patient and helpful librarian. She uses the student's name. She tries to clarify the student's request. She sends multiple resources. It takes less than fifteen minutes, however, for her to decide that the child needs a tutor, not a librarian. "I think a tutor would be better able to help you. I am a librarian."

Another librarian was more emphatic about what she could and could not do as a librarian. The student opened the transaction: "I was doing a project for school and I need to invent something and I need help, I don't have any ideas." This eleventh grader eventually communicates that she has a history assignment to invent something or make a labor-saving device. The librarian tries to send a Web site that is an idea exchange for things that people would like to see invented, but the student does not receive it. "That sounds great but I didn't get anything." Librarian resends the link and asks, "Can I help you with anything else?" The student tries to engage her personally: "Do you need anything invented to help you?" The librarian responds. "Reference librarians are here to answer questions and to make referrals to other sources of information. We cannot give advice." The student says "ok" and is linked to Live Homework Help. Another student asks: "Can you answer this? Y=2x–4 7x–5y=14." The librarian responds: "Hello, this is the reference librarian. I'm reading your question . . . [Student's name], this is a question for a homework tutor. We are an information service. I can direct you to a tutor. Would you like me to do that now?" The student says, "if you can please." A fourth librarian made a very fine

distinction in response to a student who asked, "What should I put on a poster for recruiting crew members for Amerigo Vespucci's voyages?" She said, "Well, I can give you information on the voyages, but I cannot advise you about creating your poster."

It could be argued that the librarians' efforts to clarify their roles in the above transcripts were intended to help the students get the help they really needed. These were among the more helpful librarians whose transcripts we analyzed. With the exception of the librarian faced with a math problem, they all at least tried to help with conventional information resources. Almost certainly a math tutor would be able to help the student get started with the algebra problem. Perhaps the online tutors would indeed be more effective than the librarian in helping the teens think through the science fair project or come up with an idea for a new labor-saving device. Who could best help the student at a loss as to how to make a poster recruiting crew members for Vespucci's voyages? We would argue that even these conscientious librarians would have served their young patrons better by more genuine and authentic communication strategies and less reliance on the discursive conventions that enabled them to maintain control over the transaction and decide the parameters of their helping behavior.

Most students acquiesced passively when the librarian referred them to a tutor or said they could no longer help. Many young people, however, tried to subvert the discourse by introducing a more personal tone—note the use of emoticons in the transcript above—or by confronting the librarian directly.

One boy, a repeat user, had the assignment to write about the two things he would bring if he were going to be in the mountains for one year. The librarian asks if he received the link to the tutor site. The boy replies, "ya, but you have to download it." The librarian tries to explain what he needs to do to open the site. The boy retorts: "Dude, im in fifth grade and my computer sucks and i need it by tomorrow." Another student, apparently frustrated by the ten minute wait for a librarian to come online, asks, "Hello, is ther anybody there?" A little later: "Heloooooo!"

Sending Nonverbal Messages in a Text-Oriented Discourse Environment Chelton (1998) has documented the communication disconnects that occur when teens approach the reference desks in public libraries. She describes the controlling rituals that characterize librarians' interactions with middle school students. These face-to-face encounters include not only the language used to communicate between the two parties but also gestures, facial expressions, tone of voice, and other nonverbal forms of communication. In theory, online communication lacks the emotive element of nonverbal communication. However, we observed affective as well as cognitive strategies employed by the teens and librarians as they struggled, not always successfully, to conduct online reference transactions. We documented

some of these strategies in the previous section, noting how students tried repeatedly to inject a less formal and more personal tone into these reference transactions. We believe that these represent efforts by the students to create a more comfortable discourse environment, one that is more like the chat rooms in which they communicate with their friends. For all of their familiarity with and fondness for electronic communication technology, most of the teens we observed online were not competent participants in the text-oriented discourse environment created by reference librarians. When teens go online with their friends, spelling is less important than rapid response, and capital letters and punctuation are nonexistent. The aim is to connect. Content is almost irrelevant. Indeed, when teens go online with their friends, the medium *is* the message.

Here are a few more examples of teens' efforts to inject their colloquial and personal discourse styles into their reference interviews. In one session, the librarian signs off saying "goodbye for now." The student replies: "until we meet again lol. Lol bye." What was so funny that the student was "laughing out loud"? Another student introduces herself as "Aastha" and then explains, "Think of my name as pasta. Aastha pasta!" A student asks, "What does MCLS stand for?" The librarian replies, "Metropolitan Cooperative Library System." The student says, "cool." When the librarian gives him the standard message connecting him to the tutor, he says, "no problem." When the librarian sends a student a Web page from the University of Texas, the student says, "Whoa, I need something for begginners."

When students used more colloquial or informal language conventions, it appeared to be both their natural communication style for an online chat environment and also an effort to transform the reference transaction into a more familiar form of discourse. On the rare occasions when librarians abandoned their routine professional responses and injected a more personal comment, it read like an attempt to bridge the gap and reach out to the young person somewhere in cyberspace.

Discussion

Earlier in this article we characterized contemporary good practice in public library service to young adults as being informed by the principles of youth development. The most reflective and up-to-date young adult librarians see their work as more than just providing teens with books and information. They are aiming at a broader objective: to help teens achieve the developmental outcomes of adolescence. While reading promotion and reference services are still at the heart of young adult library services, the mode of delivery and the nature of the relationship between the teen and the library staff have changed considerably in all current discussions of best practice. At their best, public libraries involve teens as meaningful participants in the planning and delivery of the services intended to benefit them. Librarians and other library staff work *with* teens in a relationship

that is qualitatively different from the more paternalistic mode of providing services *for* teens. Libraries try to provide opportunities for teens to develop interpersonal skills through healthy relationships with peers and with adults. They work with teens to determine the kinds of informational and reading resources and services they need to meet their educational and personal objectives.

The librarians in the transcripts analyzed here presumably do not see themselves as young adult librarians. It is doubtful that many of them are aware of the prevailing trends in young adult services. There is certainly little evidence in the transcripts that they are trying to work *with* their teen clients; they do not even do much *for* them in the framework of traditional reference service.

The researchers did not have access to the librarians whose transactions were analyzed. We do not know their motives or intentions. We also do not know how they interacted with clients who asked questions that were not related to homework. Perhaps they failed to follow the principles of good reference practice with all of their clients. Perhaps they maintained the same rigorous professional distance with adult clients that they did with teens. What the transcripts do reveal is a conviction that homework questions are not the proper content for reference transactions.

Certainly the availability of homework assistance programs in libraries or as adjuncts to online library reference services makes it possible to offer specialized services to students of all ages. The challenge that we have observed through our study of both onsite and online library-sponsored homework assistance is to guide the young person to the proper service, whether that is reference or homework assistance. We have observed librarians in face-to-face encounters direct students to Live Homework Help when it would have been more appropriate to show them an atlas or an encyclopedia article. We have also observed tutors giving inexpert reference assistance that librarians would have been more equipped to provide. The line between tutorial and librarian roles is blurry and awkward enough to manage when the parties are in the same building. The student may feel that he is getting the run-around when he is shunted back and forth between the reference desk and the homework center. The possibility for frustration increases exponentially, however, when the student is being shunted between frequently incompatible software interfaces by anonymous adults in cyberspace.

Radford (2001) has posited that the interpersonal nature of the reference interview is critical to the perceived success of that encounter. In fact, for some patrons the human aspects of the reference transaction may actually be more important than the information received (p. 30). Likewise, RUSA's (2004) guidelines for effective reference performance remind librarians that "the success of the transaction is measured not only by the information conveyed, but also by the positive or negative impact of the

patron/staff interaction." Therefore, the first standard of good reference service is approachability—that is, making patrons feel comfortable "in a situation that may be perceived as intimidating, risky, confusing, and overwhelming" (RUSA, 2004). The librarian who displays a helpful, patient, and reassuring attitude sets the scene for a successful reference encounter (Radford, 2001, p. 30).

Although projecting a welcoming demeanor is more difficult in the virtual realm, librarians have found ways to do this when serving remote patrons. Showing interest in the student's topic, adding humor, and giving positive feedback are all ways to exude warmth during instant messaging (Fagan & Desai, 2003). In addition, Fagan and Desai recommend avoiding library jargon and "robot-like instructions" (p. 132). Janes (2003) suggests that librarians must appreciate and understand the etiquette and lingo of instant messaging if they want teens to take the library's virtual reference service seriously. Furthermore, librarians may have to abandon their strict adherence to accurate grammar and spelling when helping students via the Internet. For many teens, a fast-moving conversation is far more important than correct spelling and punctuation (Fagan & Desai, 2003; Janes, 2002).

Finally, it is imperative that the librarian clarify the student's real information need, whether the child is standing across the reference desk or seated at home in front of a computer. This is especially critical with imposed homework questions that may not be all that clear to the student (Gross, 2000). Jones has called this phenomenon the "garbled assignment," often requiring the librarian's intervention in helping the student interpret the teacher's intent (cited in Ross, Nilson, and Dewdney, 2002, p. 147). Fagan and Desai (2003) and Ross, Nilson, and Dewdney (2002) urge librarians to work with young people to develop a mutual understanding of the homework question, while Shenton and Dixon (2004) emphasize the need to help students develop appropriate search strategies.

Conclusion

Kuhlthau (2004) has documented the affective dimensions of information-seeking behavior. Her research has highlighted the anxiety and uncertainty that students experience when they are faced with the need to do library research. She describes the information-seeking process as an effort to seek or create meaning. In the reference transactions that we analyzed, the teens attempted to create meaning by recreating the chat discourse environment in which they were most at home. Librarians, however, tried to create meaning in a parallel discourse environment that duplicated as much as possible the standard impersonal protocols of a face-to-face reference counter.

The World Wide Web promises so much to teens. Dan Tapscott (1998) makes a convincing case that these members of the "Net Generation" work,

learn, and play differently from their elders because of their immersion in the culture of cyberspace. An online chat mode would seem to be a natural delivery system for many kinds of library services to adolescents. Unfortunately, the librarians we studied seem to have grafted inferior versions of the communication styles and protocols of face-to-face reference onto some rather clunky software. It would be interesting to see what would happen if the designers of such online reference services followed the principles of good young adult library practice and involved the teens as active participants in both the planning and the delivery of the services. At the moment, teens are from Neptune, librarians are from Pluto. Better services would result if they could meet somewhere closer together in cyberspace.

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VIRTUAL REFERENCE BEHAVIORS CHECK LIST:

Transcript number:	Investigator:

GREETING	Strong Evidence	Evidence	No Evidence	N/A
1) Is available quickly	☐	☐	☐	☐
2) Gives friendly greeting	☐	☐	☐	☐
3) Encourages student to ask question	☐	☐	☐	☐
REFERENCE TRANSACTION				
4) Repeats question or paraphrases to confirm understanding	☐	☐	☐	☐
5) Clarifies question if need	☐	☐	☐	☐
6) Probes for further information	☐	☐	☐	☐
7) Helps interpret question (homework assignment) if possible	☐	☐	☐	☐
8) Verifies mutual understanding of question (homework assignment)	☐	☐	☐	☐
PROVIDING INFORMATION				
9) Finds answer in first source	☐	☐	☐	☐
10) Uses other sources	☐	☐	☐	☐
11) Communicates clearly using terminology that is easily understood	☐	☐	☐	☐
12) Checks that information is understood	☐	☐	☐	☐
13) Keeps student informed of search progress	☐	☐	☐	☐
14) Offers referral	☐	☐	☐	☐
PROBLEM-SOLVING				
15) Encourages student to solve problem	☐	☐	☐	☐
16) Advises on alternative solutions or methods	☐	☐	☐	☐
17) Reassures student	☐	☐	☐	☐
FOLLOW-UP				
18) Asks if question has been answered	☐	☐	☐	☐
19) Asks if student needs other information	☐	☐	☐	☐

Just Curious: Children's Use of Digital Reference for Unimposed Queries and Its Importance in Informal Education

Joanne Silverstein

Abstract

This research investigated the informal use of two children's digital reference services that were used for purposes unintended by the designers. The motivation for this research was to explore the ways that children bend to their own informal uses the formal tools designed to support their education. Research questions included, How and with what frequency do children use digital reference services to answer their own questions? Do digital reference services support self-initiated learning? Could digital reference services support the transfer of student motivation and curiosity from formal education to informal education? What do instructional and software designers need to consider in creating tools that support a notion of transformed education and learning? Results answered these questions and uncovered several unanticipated findings. Digital reference services were shown to support efforts to interest children in science-related careers as early as fourth or fifth grade and to support self-initiated learning in science. Unanticipated findings showed that students ask different kinds of questions as they progress through school, and they should receive training in the use of digital reference services in elementary school. Further conclusions provide insights for digital reference software and service design and suggestions for more strategic pedagogical use of digital references services.

Introduction

Children's digital reference services are a form of interactive communication technology (ICT) used to support curriculum-based education. Accordingly, most research focuses on children's use of digital reference

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services for imposed queries within a setting of formal learning. In utter disregard for educators' and designers' desires, however, children frequently send unimposed queries to digital reference services to support their informal learning needs. In a discussion of bricks-and-mortar libraries, Riechel points out the importance of considering children's informal use of formal resources: "The completion of homework assignments is all too often perceived to be the only reason to visit the library" (1991, p. xii). He states that a reference service should serve as a "primary source for the fulfillment of all information needs, not just those that are school related" (p. 120). This neglect is even more noticeable—and regrettable—in the study of digital libraries and their digital reference services, which are encountering growing numbers of self-initiated, unimposed queries from children.

The first large-scale recognition of informal learning's importance occurred in 1984, when the National Science Foundation created the Division of Informal Science Education. The division's creation was based on a report that identified museums, libraries, and other community organizations as vital to education (National Science Board, 1983). In the interim, several smaller groups and initiatives have sprung up to address research into informal education. The need and opportunity for study, however, currently outstrip the attention given by scholars. One reason for this dearth of attention is that research on this topic is inherently difficult: it usually relies on children's communication skills to write (in logs), organize thoughts (in interviews), and articulate logical abstractions (in think-aloud protocols). Children, however, possess varying cognitive skills and may not be able to participate in these research methods. The difficulties of this work, however, must be overcome because more than 85 million U.S. children are on the Internet (U.S. Census Bureau, 2001), and, to some degree, their future success depends on their ability to use the Web effectively to find and use information.

The research reported in this article was undertaken to address this shortage of information and to explore Sefton-Green's (2004) notion that research on the use of ICTs for informal learning may reform educational theory and transform the nature of education altogether: "young people's interaction with ICTs outside of formal education is a complex 'educational' experience" that will compel us to redefine "simplistic definitions of learning and education" (Sefton-Green, 2004).

Definitions of Informal Learning

"Informal learning" is one of many terms that have been applied to learning outside of school. It is related to Oldfather's and McCaughlin's (1993) "continuing impulse to learn." Similarly, "interest" is expressed as the degree of interactivity between a student and an object (Livingstone, 2001), with students who have higher interest in a topic capable of

more engagement and persistence (Alexander et al., 1997; Krapp, Hidi, & Renninger, 1992; Schiefele, 1998.) Often, this higher interest is called intrinsic motivation—learning for inherent satisfaction (Ryan & Deci, 2000)—and constitutes a desirable educational outcome in itself (Krapp, 2002; Ryan & Powelson, 1991). Intrinsic motivation requires no gold stars, no grades, and no classroom pizza parties. In fact, such external motivators may inhibit and erode natural intrinsic motivation (Deci, Koestner, & Ryan, 2001). Deci and Ryan (2000) suggest that, when students are encouraged to bring their own experiences and prior knowledge to the teaching setting, they are more motivated to pursue self-initiated learning. Further, self-initiated learning is a defining behavior of lifelong learners and a desirable goal for all students. These descriptions provide a general understanding of informal learning. A more specific description, however, is needed for further research; it is based on two contexts of informal learning.

First, within the context of education, Sefton-Green (2004) defines three kinds of informal learning, all of which occur in nonschool environments: educational experiences provided to support curricula; educational experiences provided to support socially important, but not curriculum-related, learning; and leisure activities outside the realm of socially valued educational experience. The setting for this study is a pair of digital reference services that provide out-of-school information about curriculum-related and socially valued topics—a combination of Sefton-Green's first two definitions.

A second context for defining learning is found in library science, where learning occurs when users pair information needs with search words and query the system, collection, or librarian. Queries that come from students preparing for homework assignments, test preparation, and report writing are said to be "imposed queries" (Gross, 1998). "The imposed query . . . differentiates between information seeking that is self-generated (internally motivated in response to the context of an individual's life circumstance), and imposed information seeking, which is externally motivated, being set in motion when a person gives a question to someone else to resolve . . . such as school assignments" (Gross, 1998, p. 290). Gross's self-generated information seeking may be thought of as an "unimposed query," which is, for the purposes of this research, equivalent to a "Just Curious" query. This study investigates what happens when children use tools originally designed to support the answering of imposed queries to answer their own, unimposed queries in pursuit of informal learning. In summary, and for the purpose of this research, informal learning is defined and operationalized as unimposed queries that children send to digital reference services—services that were originally intended to support only imposed queries directly related to curricula.

Informal Learning and Digital Reference Services

The digital reference service (also known as an AskA service) is an ICT that enables expansion of library services by providing outreach and human intermediation in response to users' emailed queries; it is integral to the digital library (Lankes, 2002). Digital reference services are becoming increasingly specialized to serve specific user populations, one of which is children. An important characteristic of children's services is that they are designed to support learning about specific subjects that are linked to school curriculum topics. For example, Ask A Mummy (http://www.mummytombs.com/main.questions.htm) is designed to help children learn about the history of Egypt, which is a component of their curriculum. In another example, Ask Jake the Sea Whale (http://www.whaletimes.org/whaques.htm) provides children with expertise about marine biology and zoology—also components of their curriculum. Frequently, however, students use these formal education tools to obtain information about their informal information needs. It is the use of formal digital reference services for these informal information needs that is the topic of this research.

The Research Questions

A casual review in 2004 of questions from a children's science-oriented AskA service—in which it was expected that most of the questions would be science related—showed that many questions were informal and not science related. Upon reviewing some of the data, four research questions evolved:

- How and with what frequency do children use digital reference services to answer their own questions (unimposed queries)?
- Do digital reference services support self-initiated learning?
- Could digital reference services support the transfer of student motivation and curiosity from formal to informal education and learning?
- If so, what would instructional and software designers need to consider in creating tools that support Sefton-Green's (2004) notion of transformed education and learning?

Methods

The Information Institute of Syracuse at Syracuse University's School of Information Studies supports many digital reference services, two of which are intended for use by students. One is the Virtual Reference Desk's (VRD) Learning Center (http://vrd.askvrd.org/search.asp), and the other is a yearly, week-long, digital reference service sponsored by the National Science Foundation (NSF) during Excellence in Science, Technology, and Mathematics Education Week (ESTME) (http://www.estemeurlhere.com). ESTME 2004's digital reference service was designed to encourage students' interest in mathematics and science and recruited more than 300 experts

who volunteered to answer almost 600 questions from students, teachers, parents, and the general public. Questions from the VRD's Learning Center and NSF's ESTME week-long service were compiled in one database, processed (as described below in Data Processing), and analyzed using inductive methods (described below in Inductive Analysis).

Data Processing

Both the Learning Center and the ESTME digital reference services provided pull-down menus so users could describe their roles (for example, student, teacher, parent) and the uses to which they would put the answers (for example, written report, science fair project, just curious.) Only questions that were asked by "students" who marked the "just curious" category were kept in the database. Duplicate questions, defined as identically worded queries submitted almost simultaneously, were stripped from the database. Questions that seemed obviously mislabeled were removed from the database for the sake of accuracy. For example, several questions were labeled as being asked by elementary school children, but the wording ("My child wants to know . . .") showed that adults actually submitted the questions.

Questions from students in grades K–5 were coded "Elementary Student." Questions from students in grades 6–8 were coded "Middle School Student," and questions from students in grades 9–12 were coded "High School Student." A total of 114 unique questions (35 from the Learning Center and 79 from the ESTME service) remained.

Inductive Analysis

The 114 unique questions were loaded into HyperResearch, a qualitative software application for inductive analysis. Inductive data analysis requires the researcher to set aside biases from experience and knowledge of the literature and to let the data speak for themselves. Qualitative analysis software was chosen over manual analysis procedures because it enables methodical, replicable, and well-documented analysis of patterns and hypotheses as they emerge from the data.

The decision to use only inductive analysis was reached after a review of the literature, specifically in the domain of question taxonomies. A taxonomy created by Graesser, Lang, and Horgan (1988) potentially seemed the most useful. Upon closer study, however, several aspects of the taxonomy precluded its use in this study. First, it categorized questions articulated by adults, but children do not necessarily ask the same kinds of questions as adults. Second, the questions that work were imposed and based upon assigned readings. The requisite question domain for this study, however, was informal questions stemming from students' self-initiated interests. Finally, in a dry run of coding according to the Graesser, Lang, and Hor-

gan taxonomy, many of the children's questions fell into one and only one category, "Concept completion." This is useful information but not sufficiently descriptive to support a deductive research method. Thus, the deductive approach of existing taxonomies was discarded, and inductive analysis was used for the remainder of the analysis. Inductive data analysis allowed identification of forty-three topics or codes. The co-occurrences of some codes revealed findings that are reported in the next section.

Findings

Inductive coding occurred in two phases, first providing descriptive findings and then unanticipated findings.

First Phase of Coding: Descriptive Findings

The first phase of coding was useful for identifying compound questions, which refined the unit of analysis from user to query, and for showing the informal uses of digital reference services by grade level.

Compound questions and the unit of analysis The original unit of analysis for this research was the individual email that contained the student's question. Many students, however, asked several questions in one email, and most often they addressed different topics. One middle school student asked the following compound question, "What is at the core of the Earth? How do you know what is there because no one or thing has ever gone there?" The two queries in this question are related, but the first query requires a "ready reference" answer, and the second query requires a discussion of geological research methods and the scientific method. The presence of compound questions required changing the unit of measurement from emailed question to the individual query within the email. Within each compound question, queries were coded separately from others in the same email message. The number of emailed questions (114) yielded a total of 150 individual queries. Thirty-two percent of all queries were part of compound questions, and that percentage was evenly distributed across the three groups (elementary, middle school, and high school). Because the total number of queries from each grade level group differs, the remainder of the findings will be presented in percentages.

Use of digital reference services by grade level The first phase of coding also showed use by grade levels. Elementary school students submitted a large portion of the questions, and middle school students asked the most questions (see Figure 1). Older students submitted far fewer questions, indicating that high school students are not currently using digital reference services—a finding confirmed in Silverstein (2004).

In summary, descriptive data resulted from the first phase of coding and created the foundation for the second phase of coding, which generated unanticipated findings.

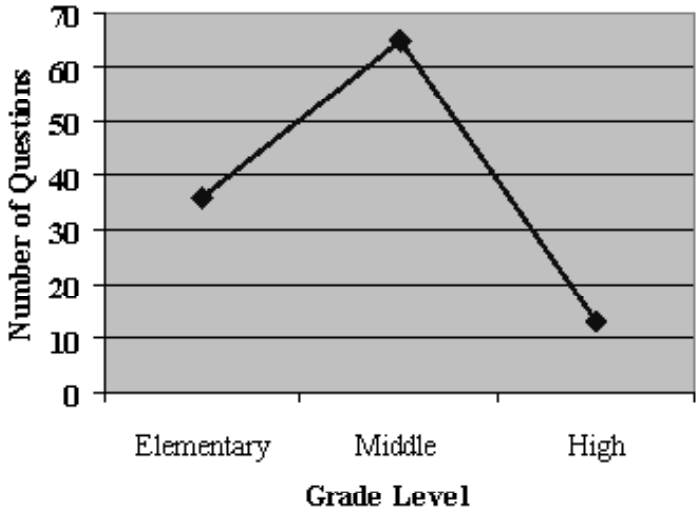

Figure 1. Number of questions by grade level.

Second Phase of Coding: Unanticipated Findings

A second phase of data analysis was based on codes from the first phase and resulted in three groups of unanticipated findings. These findings showed that students used the digital reference services

- for six categories of query foci that shift over time
- to support informal queries related to formal school work
- to ask informal queries about specific topics, including but not restricted to Career Planning, Health and Welfare, and Death and Anxiety

Query foci Each of the 150 queries could be assigned exclusively to one of six categories of Query Focus, including; "My Life," "My Stuff," "Other People," "The World," "The Universe," and "Abstract Thought." These categories are defined in Table 1.

Further analysis showed that the students' grade levels often correlate with specific query foci. That is, students seem to be interested in certain foci, and those interests may shift over time. Figure 2 shows the number of queries arranged by query focus category and grade level group. Forty-five percent of elementary school queries express interest about how the world works, while middle school students are increasingly interested in abstract or conceptual issues. High school students seem to have the narrowest foci; they are increasingly absorbed in the immediate circumstances and artifacts of their world ("My Life" and "My Stuff") and less interested as the focus

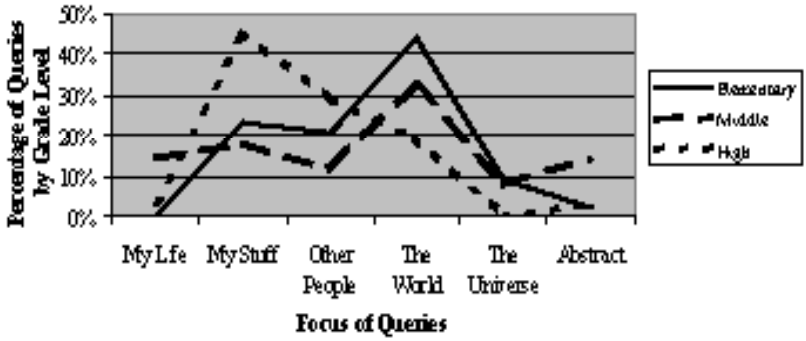

Figure 2. Query focus by grade level.

widens to other people, the world, and the universe. Findings suggest, then, that the topics about which a student is just curious may shift, over time, from "how the world works" to "how my world works.".

It is necessary to point out that the student participants in the three grade-level groups (elementary, middle school, and high school) did not comprise one population observed longitudinally but three separate groups of participants. Thus, this research suggests, rather than claims, that the foci of students' digital reference queries change over time.

Informal queries related to formal school work "Just Curious" users submitted very few queries that directly addressed "School-Related Learning," such as, "How do you study for a test?" and "What is 64 divided by .78?" Queries that were coded "School-Related Learning" comprised less than 8 percent of all queries, suggesting a negative correlation between children's intrinsic curiosity and assigned work.

Table 1. Query Focus Categories and Definitions

Query Focus Code Category	Definition
My Life	Students' queries about their families, their health, or their futures
My Stuff	Students' queries about the immediate circumstances or artifacts of their lives
Other People	Students' queries about people, alive or dead, about whom the student is curious but to whom s/he is not directly related by family or other personal association
The World	Students' queries that address nonpeople components of the world or how the world works
The Universe	Students' queries about space or how things work beyond our world
Abstract Thought	Students' queries that are philosophical or conceptual in nature

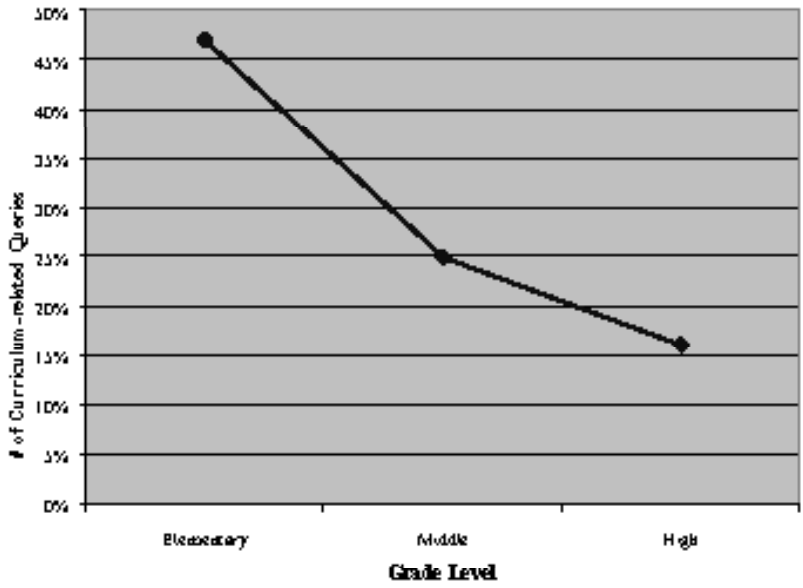

Figure 3. Curriculum-related interest by grade level.

Conversely, the code category "Curriculum-Related Interest" is particularly relevant to informal learning because it indicates that a student's query was unimposed but may have been stimulated by classroom learning. More to the point, "Curriculum-Related Interest" describes queries that represent curiosity that may have "carried over" from formal learning (extrinsic curiosity) to informal learning (intrinsic curiosity). "I want to know about Hercules. It's not for school," is an example of a query that was coded "Curriculum-Related Interest."

Figure 3 illustrates that "carry over" from the classroom to informal learning is at its highest in elementary school and drops off over time. Again, these findings reflect the interests of three different groups of student participants and only suggest that these changes may occur over time in the same population.

"Curriculum-Related Interest" queries were divided by grade level and subdivided by academic subject (for example, science, language arts, etc.) in hopes of identifying which school subjects most easily "carry over" from the classroom to the informal environment. Since one of the two digital reference services was intended to provide answers only to science-related questions and would have skewed the data, however, this approach was abandoned.

The data did provide an opportunity to examine the percentage of queries that were coded "Curriculum-Related Interest" and were science

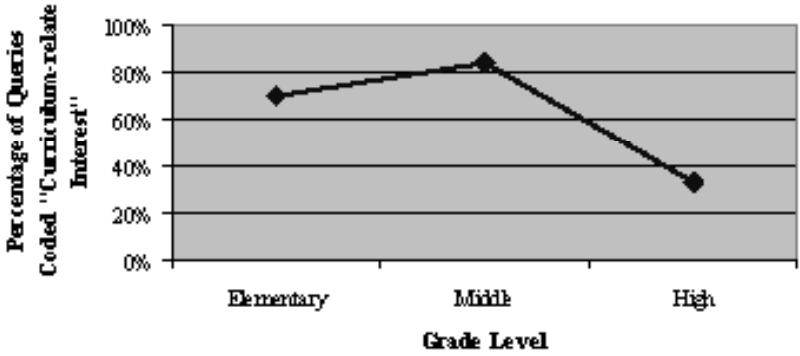

Figure 4. Informal science learning by grade level.

related by grade level. Those data are laid out in Figure 4 and suggest that students' inclination for informal learning about science is greatest in middle school. Out of nineteen "Curriculum-Related Interest" queries asked by middle school students, sixteen were about various aspects of science—the percentage increased steadily through elementary and middle school and dropped away in high school.

Finally, nearly half of all queries from elementary school students were coded "Curriculum-Related Interest," indicating that, during the elementary school years, students' curiosity is more influenced by school curricula than it is in later years.

Informal queries about Career Planning, Health and Welfare, and Death and Anxiety Many queries addressed topics that were not intended to be supported by the digital reference services, and some of those topics appeared in disproportionately large numbers. These topics included Career Planning, Health and Welfare, and Death and Anxiety and were most frequently addressed by middle school students. At that time, for example, some students begin to ask specifically about preparing for a career, submitting queries such as, "I was wondering if you needed to know any mathematical knowledge to become a nurse?"; "Other than being a doctor, what are some other occupations I could do with a medical degree?"; and "I was wondering what education a Marine Biologist must go through, and if they can work to save animals and study them?" Children in this study also asked many informal questions about health-related issues. "How can you tell what kind of sickness you have, how do you know if you are going to die, and what kind of medicine you need?"; "Do personality disorders run in the family"; and "Is there anything you can do to make sure you have a girl when you get pregnant?" are several examples.

Finally, middle school students begin to think about their places in the world and the nature of mortality. Approximately 4 percent of queries expressed curiosity about students' health issues and mortality in general queries ("Why do people die?"; "Why do children get life threatening diseases?") and in more specific queries ("How am I going to die?"; and "Are [you] scared to die?").

A summary of the findings shows that two phases of coding established the unit of analysis and generated both descriptive findings and unanticipated findings as listed here:

- The use of children's digital reference services is high in elementary school, peaks in middle school, and greatly diminishes in high school.
- During the elementary school years, students' curiosity is more influenced by school curricula than it will be in later years.
- During the middle school years, use of digital reference services for informal learning about science is at a peak.
- Over the years of K–12, informal information seeking may shift in focus from a world perspective to a personal perspective.
- Students seemed generally uninterested in pursuing school-related topics solely for the sake of curiosity.
- Students used formal digital reference services frequently to pursue three topics of informal information seeking: Career Planning, Health and Welfare, and Death and Anxiety.

Conclusions

The original four research questions listed above are addressed in this section. An additional section, "Other Conclusions," describes unanticipated conclusions that are outside the scope of the research questions.

1. How and with what frequency do children use digital reference services to answer their own questions (unimposed queries)?

Elementary school students asked thirty-six "Just Curious" questions, middle school students asked fifty-nine, and high school students asked nineteen. In grades three through eight, student curiosity is stirred by school work, and use of formal services to pursue informal information seeking about science peaks. Late elementary school and early middle school students make the greatest use of services to pursue their interests in the world, which declines soon thereafter. Older students seemed uninterested in pursuing information about school-related topics for the sake of curiosity, but they frequently used formal digital reference services to pursue information about three topics: Career Planning, Health and Welfare, and Death and Anxiety.

2. Do digital reference services support self-initiated learning?

Of all the 2,258 original questions submitted to the two digital reference services in this research, students' unimposed or self-initiated ques-

tions—the ones labeled "Just Curious"—numbered 297. The fact that 13 percent of all questions submitted to two formal services were informal illustrates that students made substantial use of the digital reference services—and indicates that digital reference services do support self-initiated learning, a conclusion not discussed in the literature about digital reference services.

3. Could digital reference services support the transfer of student motivation and curiosity from formal to informal education and learning?

Queries that were coded "Curriculum-Related Interest" represented instances in which school work stimulated students' need for informal information. This "carry over" from extrinsic to intrinsic curiosity occurred most frequently in elementary grades, when students' curiosity seemed most deeply influenced by school curricula. Thus, one may conclude that digital reference services can effectively support the transfer of student curiosity from extrinsic to intrinsic, and from formal to informal education, at least for some populations. The literature on digital reference services shows little previous interest in, or findings related to, this fact.

4. What do instructional and software designers need to consider in creating tools that support Sefton-Green's (2004) notion of transformed education and learning?

Findings uncovered several areas of potential interest to software designers and instructional designers. First, occurrences of duplicate questions may indicate that users are experiencing difficulty with digital reference software or that the software is malfunctioning. Many duplicate questions were received by the two digital reference services that participated in this research. It was impossible to know, however, exactly what kinds of difficulties students encountered in submitting their questions. Consulting with students would help software designers create interfaces that support the students' information-seeking needs and seem more intuitive to them. This practice has been used successfully in creating children's online tools and digital libraries (Druin, 2002) and would be helpful in the design of children's digital reference services.

Second, many questions contained compound queries. This may be a natural tendency, especially as students become cognitively more sophisticated and ask hard-to-answer questions. Software, however, must be "taught" to separate the queries, perhaps refer them to different experts, archive them separately, and yet be able to re-combine them for responding to the student. Multiple referrals would require specialized tracking systems to ensure that users receive complete answers. The topic of compound questions is not widely addressed in the digital reference literature (Lankes, 1999).

Third, results suggest that the elementary school years are optimal for introducing digital reference services. Instructional designers could build on this finding by creating interfaces that support the elementary student's information needs. For example, it may be possible to create interfaces

that change longitudinally, along with the students, to accommodate personal and cognitive changes as their foci move from how the world works, to abstract issues, and then back to the students' private worlds. One way to approach this daunting task is to include child psychologists in design development for digital reference services. More important, software and instructional designers should work with students, letting them guide the creation of functional specifications, especially with regard for interface design and information retrieval. The concept of longitudinally dynamic interfaces for children's digital reference services is not discussed in the literature.

Other Conclusions

Four unanticipated findings support three miscellaneous conclusions. The first conclusion is that digital reference services should broaden their topical domains to include topics of urgent concern to children, and they must improve services to better answer questions about those concerns. As mentioned in a previous section, students begin to articulate concerns about health and mortality in middle school. This information alone is somewhat interesting but, viewed within the perspective of information provision, it points to a gap in children's online information services. Health worries are not necessarily school related, but addressing them is important to students' abilities to learn. One could imagine, for example, digital reference services that link to various kinds of anonymous counseling services. Children who are ill, or whose parents are ill, could be directed to online support groups with other children or to chat rooms with school counselors, or they could be linked to online sites that provide information about specific illnesses. There is some discussion of children's online health information services in the medical literature, but the connection has not been made to children's digital reference services.

A second miscellaneous conclusion is that digital reference services could support efforts to interest children in science-related careers as early as fourth or fifth grade. Two findings—that middle school students show the most interest in careers, and that they are the most likely group to pursue informal learning about science—support this conclusion. A final miscellaneous conclusion is that elementary school students should receive training in the use of digital reference services, a pedagogical practice that would support the impending middle school burst of interest in using informal learning tools to learn about science.

A brief review of the conclusions shows that they contribute to research and practice: The conclusions that digital reference services support self-initiated learning and the transfer of extrinsic curiosity to intrinsic curiosity have been undocumented in the literature for digital reference services and in the literature for curiosity and motivation in learning. Further, some of these conclusions provide insights for digital reference software

and service design and suggestions for more strategic pedagogical use of digital references services.

Limitations

Four limitations may have affected the results. First, this research was based on data from two digital reference services. One was designed to answer questions about all academic subjects, but the other was designed to answer only science-related questions. This circumstance skewed the frequency of questions toward science topics. Therefore, attempts to identify those academic subjects about which informal learning most easily "carries over" from the classroom to the informal environment were abandoned.

Second, some data were lost because teachers, librarians, and parents registered as students. The language of these queries (for example, "For a lesson plan I am preparing, I need . . .") revealed the nonstudent status of the user.

The third limitation to this research only became clear in the data analysis stage. Plotting trends among the three grade level groups (K–5, 6–8, and 9–12) showed distinct similarities among the members within specific grade level groups and distinct dissimilarities between the grade level groups themselves. One could conclude that these patterns change for all students as they proceed through grade levels. That conclusion, however, can only be suggested here and must wait for a longitudinal study to be proven.

Fourth, not all hypotheses could be tested. Within the framework of inductive analysis, hypotheses may be thought of as explanations of relationships among the code categories. Examination of all permutations of the forty-three codes, however, would result in almost nine trillion combinations, each of which would be a potential hypothesis. Instead, only several hundred query combinations were run, and they were based on iterative attempts to find the most fruitful queries. Of those, only the combinations that showed trends and patterns are reported here.

Future Research

Conclusions from this work have suggested four new questions for future research. First, digital reference librarians need more context than students currently provide if they are to formulate useful answers to students' questions. Digital reference services allow the exchange of some contextual information, but students rarely provide this information when submitting questions. In some cases—when students ask about career planning, for example—digital reference librarians may feel confident that they know what the user wants and how the information will be used. In most cases, however, librarians do not know what motivated the questioner or how s/he will use the information. Research has not focused on students' motivation in information systems (Small, 1999). Yet, knowing the user's objective in

asking a question is critical to determining what kind of information should be provided in an answer (Taylor, 1968). Therefore, it is important to consider that children use digital reference services to ask questions in which their motivations and objectives are not stated. These kinds of queries may signal opportunities for useful educational interventions, such as counseling, referral to other kinds of experts, or mentoring. First, however, future research must provide a means for including context in students' questions and must address the research question, "How can digital reference services capture and integrate the context of students' questions?"

A second topic for future research is determining how students' needs for digital reference services change over time. Findings have shown that the foci of student queries shift over time. Can designers create software that automatically, dynamically, and longitudinally supports those changing needs and encourages self-initiated learning?

Third, this research has shown that digital reference services support science learning, particularly in middle school. Future researchers might consider the question, "How can digital reference services support learning of other academic topics, and in other age groups?"

Fourth, one finding of this research showed that children may be experiencing difficulties operating digital reference software. A result was the submission of duplicate questions, and a suggested solution was that software designers consult with children. Other findings show that children ask specific kinds of questions, which implies that their digital reference systems should not necessarily be modeled on those designed for adults. These observations suggest that future researchers should address the question, "How can we include children in our research and enable them to contribute to the design of their own digital reference services?"

Summary

The goal of this study was to investigate the unintended use of children's digital references services for informal learning and to determine how resulting knowledge could benefit the users and designers of those services. The findings and conclusions indicate that a deeper understanding will benefit software and instructional designers. They may wish to consider ways to create software that supports informal as well as formal learning. More specifically, they may wish to consider creating student-reflective services that are co-designed with the students and that change along with them.

Deeper understanding will also benefit digital reference librarians and classroom educators, who can use digital reference services to support and stimulate students' intrinsic curiosity beginning in elementary school. Most important, students will benefit by having at their disposal—at any time and place—tools that reflect their information-seeking needs and enable contact with experts who can answer their questions—both formal and informal. It is hoped that conclusions from this research will contribute to

the literature about digital reference services and to the literature about curiosity, ultimately improving the ability of digital reference services to sustain students' continuing impulse to learn.

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Initial Findings from a Three-Year International Case Study Exploring Children's Responses to Literature in a Digital Library

Sheri Massey, Ann Carlson Weeks, and Allison Druin

Abstract

This article examines children's responses to self-selected books in a digital library and begins to identify patterns in those responses. As part of a larger longitudinal study, the study presented here is an analysis of 241 book response forms submitted by 12 children from 4 countries: Germany, Honduras, New Zealand, and the United States. The children described most of the books they read as being funny or happy and generally rated them with four or five stars (out of five stars). The most commonly identified types of responses were those expressing like or dislike, summarizing the text, or explaining how the book made the child feel. Two factors were identified that influenced response patterns from the study sites: the data collection instrument and adult mediation. This research has implications for library program development related to recreational reading and for changes in the procedures for data collection in this area of research.

Introduction

It is important that school and public librarians understand how children respond to the literature they read not only for school but recreationally so that they can effectively develop collections and programs that address and respond to children's interests. Library professionals serving children all over the world share this responsibility, which is amplified by the need to provide effective services to increasingly diverse user communities from Emporia, Kansas, to Wellington, New Zealand. While many studies have looked at cross-national assessments of students' school achievement in various subject areas (Forshay & Husén, 1962; Heyneman, 2004; Interna-

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tional Association for the Evaluation of Educational Achievement [IEA], n.d.; National Center for Education Statistics [NCES], n.d.; Purves, 1973), few studies in the library and information studies literature have investigated the responses that children have to books read aesthetically, or recreationally. Virtually no international comparative studies have been done to explore children's responses to books read "for fun" across countries or cultures because until recently it has not been possible to provide identical collections of materials simultaneously in multiple locations.

Today, however, Internet technology makes it possible for users all over the world to access the same collection of materials on demand through digital libraries. With the development of digital collections, such as the International Children's Digital Library (ICDL), created in 2002, it is now possible to explore patterns in readers' responses to self-selected items in multiple international settings. By exploring patterns in readers' responses in different nations and over time, this research may begin to provide a greater understanding of children's interactions with books selected for recreational reading. This knowledge can then be applied to the tailoring of collections and services that better meet children's dynamic information needs. The work presented here offers a unique glimpse at international patterns in reader response and begins to address the paucity of reader-response literature in the library and information studies field. This article presents the preliminary findings from year one of a three-year longitudinal study designed to investigate that relationship. This research is guided by the following questions: What patterns exist in children's responses to literature? Do variations exist by country? If so, what factors influence those variations?

Previous Research: Reader Response Theory

Reader response theory posits that every reader constructs meaning from an interaction with a literary work. This constructed meaning is greatly influenced by factors such as feelings, beliefs, the structure and elements of the text, and the reader's context at the time of the interaction (Probst, 2003; Rosenblatt, 1978). Reader response theorists also hold that the reader's response may change frequently and dramatically during an interaction with a text (Newton, Stegmeier, & Padak, 1999; Rosenblatt, 1991). This one-to-one interaction between the reader and the text is known as a "literary transaction" (Hepler & Hickman, 1982; Rosenblatt, 1978).

Martinez and Roser (2003) report that, although adults and children process meaning in literature differently, young children are capable of making interpretations, thematic statements, and connections to their lives from what they read. Probst (2003) focuses on children's responses to literature, adding that, as individuals, children bring different experiences, histories, beliefs, contexts, and purposes to the act of reading, and, therefore, their responses and interpretations of what they read will differ. Meaning, he adds, is created from the interaction between the reader and the text.

Since the late 1920s, reader-response researchers in education have attempted to understand the transaction that takes place when children read a literary work (Probst, 2003). Although reader-response research has considered the context, or settings, in which reader response takes place—including the home, classroom, and society—little research has examined international settings since Purves's (1973) nine country study. In his research Purves examined the relationship between culture and reading comprehension and found that the environment (home and school) had a stronger effect on comprehension than did the school curriculum.

Library and information science (LIS) researchers also have begun to look at children's reading responses (Steinfirst, 1986; Vandergrift, 1987). Steinfirst (1986) examined the usefulness of reader-response criticism as a method for understanding children's engagement with literature. In an empirical study, Vandergrift (1987) analyzed students' responses to fantasy and discussed the implications those responses could have for collection development and program planning for children. In later research Vandergrift (1990) tested a model of children's meaning-making processes with ninth and tenth graders from three urban high schools in the United States. The model depicted readers moving from very personal, or "felt," responses, to more public, or "social," responses. Upon analysis of students' written and oral responses to "My Friend Bobby," a science fiction short story from *The Counterfeit Man* (Nourse, 1967), she found that the model was not disproved and that the students grew to appreciate their personal responses and to understand the social construction of meaning.

There is a need to continue Vandergrift's research by further investigating how reader-response findings can be used to improve library services to children. While educators have explored students' responses to literature in the classroom, LIS research may add to this body of work by exploring the responses that children have to books that are read for pleasure. With a better understanding of how children respond to literature, in both digital and physical formats, library and information science professionals can more effectively develop policies, collections, and programs that complement the needs and interests of their local youth populations.

The Research Study, Participants, and Locations

The ICDL is a research project that focuses on creating a digitized collection of international children's books available on the Web. A major function of the research is to develop a greater understanding of the relationship between children's access to a digital collection of multicultural materials and their attitudes toward books, libraries, reading, technology, and other countries and cultures (University of Maryland, 2002a).

As part of the ongoing research, the research team is examining the longitudinal effects of the digital library on young users. The research findings reported here represent a smaller piece of a more extensive ICDL

development and implementation project. The full study, including the aspects of the research being reported in this article, is being implemented in four locations: Wellington, New Zealand; La Ceiba, Honduras; Munich, Germany; and Chicago, Illinois. Site selection was based on the ability to identify children from diverse ethnic and economic backgrounds, as well as the opportunity to take advantage of existing relationships with schools and libraries around the world. The twelve children in the study were eight years old and in the third grade when the study began. Research team members asked a librarian or classroom teacher in each of the four sites to work with school administrators and other educators to identify the child participants. The site representatives were asked to identify children who were eight years old; who were able to speak and understand English to enable communication with the research team; who were likely to continue at the school for the three years of the study; and whose parents were likely to support the research. In addition, the researchers asked that the child participants be of both genders in each setting. The children were not meant to be representative of the entire population of the country nor the demographics of the school. Using the above criteria, the school staff selected the children for the study. Table 1 presents additional site information.

The Digital Library Materials

The ICDL is unique as a digital library for children in that it is a collection of fully digitized children's books from countries around the world. Readers have access to more than just pointers or bibliographic records leading to where the book physically exists. The entire content of each book is available online and without cost day or night (see Figure 1).

This new kind of library, which exists simultaneously everywhere and nowhere, makes research exploring international use of the same collection possible. At the time of this study, the digital library included books in multiple languages, both picture books and chapter books, fiction and nonfiction titles, and historic and contemporary materials. Materials in the collection are designed to be appropriate for and of interest to children ages three to thirteen years. The age range for the collection spans a wide spectrum of ability and interest levels, and not all materials are appropriate for all visitors to the library; however, the collection was sufficient for the purposes of this study.

The children in this study were provided with laptop computers containing a local version of the ICDL as it existed in the summer of 2003. At that time the library collection was made up of 261 books. Over half of the collection (151 books) was in English, representing primarily literature from the United States. Books in Arabic (29 books) and Spanish (22 books) published in multiple countries represented the next largest group of titles in the collection. The ICDL initially categorized books as either short or long. At the beginning of this study, picture books, or short books,

Table 1. A Profile of Each Study Site and Its Participating Children

Country	Germany	Honduras	New Zealand	USA
City	Munich	Le Ceiba	Wellington	Chicago
Public/Private	private international school	private school	public school	public school
Student Ages	pre-K (age 3) to 12th grade (age 18)	1st grade (age 6) to 12th grade (age 18)	Kinder (age 5) to 8th grade (age 14)	Infant (6 months) to 8th grade (age 14)
Student Population	-600 students -65 nationalities -mid-high income -majority intact families	-300 students -primarily Spanish -middle income -majority intact families	-250 students -22 cultures -low-mid income -majority divorced families	-800 students -African-American -low income -majority single-mother families
School Curriculum	-international baccalaureate program -taught in English & German	-more traditional teacher-driven lessons -taught in English & Spanish	-child-centered constructivist pedagogy -taught in English & Maori	-teacher-centered with focus on discipline -taught in English
Library	2 libraries with 10,000 books total	1 library with 10,000 books (50% outdated)	1 library with 6,000 books	1 library with 7,000 recently purchased books
Facilities	-technology-rich -expansive physical space	-partial technology integration - expansive physical space with security	-lack of technology -lack of physical space	-technology-rich -expansive physical space (new building)
Parental Involvement	-parent advisory group	-parent advisory group	-Parent Board of Trustees who hire/fire school staff	-Parent-Teacher Association (PTA)
Child Research Participants	-1 German -1 German/British -1 British -2 girls & 1 boy -all speak English & German	-all Spanish -2 boys & 1 girl -all speak English & Spanish	-1 Maori (indigenous tribal culture) -1 British/Indian -1 continental New Zealander -2 girls & 1 boy -all speak English	-all African- American -2 girls & 1 boy -all speak English
Children's Pseudonyms	Gail, Manfred, Skylar	Antonio, Arcelia, Juancarlos	Ojas, Maata, Caroline	Kendis, Safara, Chalondra
Adult Research Participants	-6 parents -1 teacher -2 media center staff -1 principal	-6 parents -1 teacher -1 media center staff -1 principal	-3 parents -2 teachers -2 media center staff -1 principal	-3 parents -2 teachers -1 media center staff -1 principal

Source: Druin (2004).

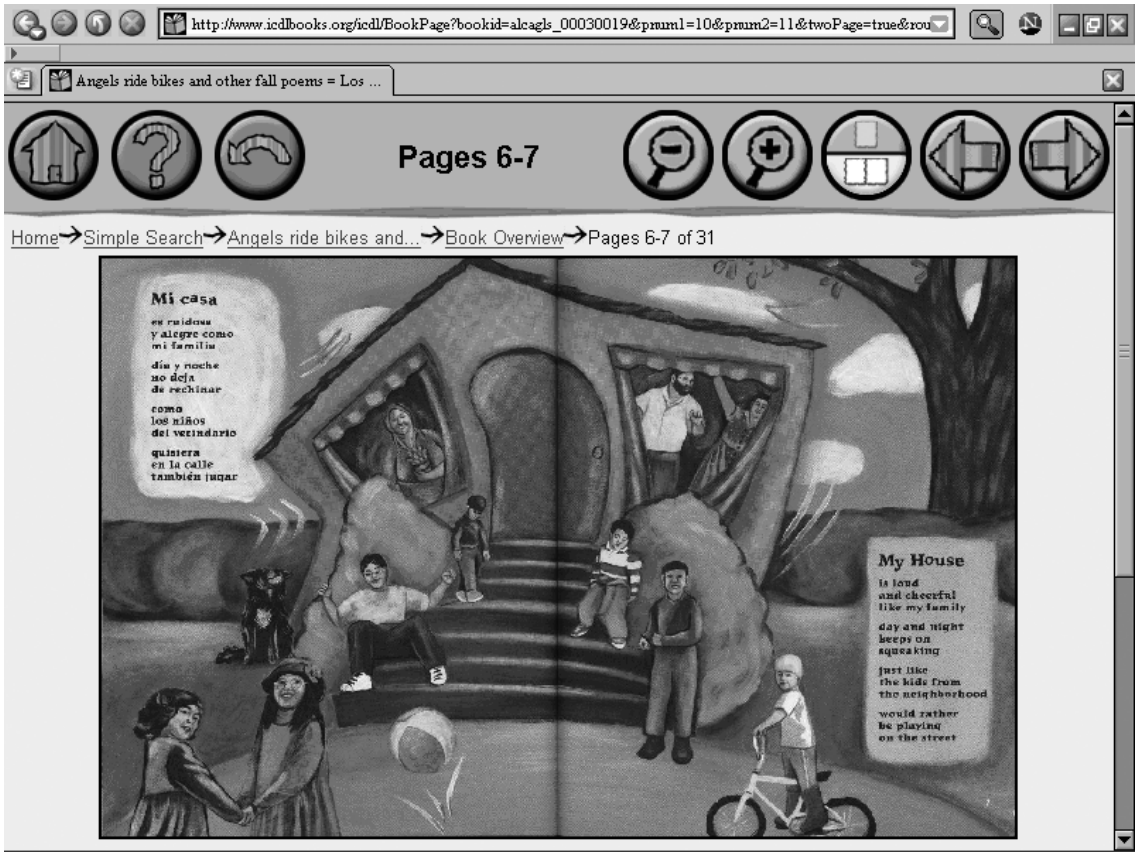

Figure 1. Sample Page from the ICDL

comprised half of the collection (141 books) and chapter books, or long books, made up the other half.

The majority of books in the locally loaded ICDL were not categorized by feeling or rating. Only 90 books included feelings and/or ratings data because only feelings and ratings data determined by children are included in the metadata. Assigning feelings and star ratings to books is an ongoing process done by six child researchers ages seven to eleven, who work regularly with the interdisciplinary research team at the University of Maryland that is creating the ICDL (Druin, 2002). Because the process is ongoing, only those books that had been read, reviewed, and categorized by children prior to the beginning of the four country study were able to be searched initially using the feelings and ratings categories. The children in the four country study were encouraged to contribute to the feelings and ratings data regarding the books that they read throughout the year.

In the locally loaded version of the ICDL used by the children in this study, most of the books that had been categorized by feelings were labeled as happy (43 books) and funny (32 books); sad and scary books accounted for 15 books. Of the 68 books with rating data, 34 were rated with four stars, 32 were rated with five stars, and 2 were given the three-star rating. The collection also was divided into fact and fiction, or True (32 books) and Make Believe (209) books. Finally, the ICDL collection contained both historic and contemporary titles from around the globe. Of the 261 books accessed locally by the children, the majority (152) were contemporary or "in copyright" titles.

Methodology

The team chose qualitative inquiry methods for this study because the research questions required in-depth information for answers rather than a one-time collection of statistical data (Neuman, 2003). These methods allowed researchers to study reader response holistically, resulting in the identification of patterns that emerged from the data (Bunbury & Tabbert, 1988; Creswell, 1994, 1998; Maxwell, 1996). In qualitative research, data are often collected from multiple participants in multiple forms in order to triangulate information sources (Creswell, 1994, 1998; Maxwell, 1996). For this study the sample was purposive, intended to "maximize the range of information collected" (Guba & Lincoln, 1982, p. 248). The twelve children from diverse settings contributed response data and therefore contributed twelve perspectives. These perspectives illustrated common characteristics within and across countries. Children's overlapping perspectives showed how they were able to respond to literature consistently.

Data Collection

The full data collected for this longitudinal study will include interviews, book response forms, Web pages, drawings, and observations in each of

the four sites over the course of three years. For this study-within-a-study, the authors chose to analyze the book response forms. The response forms were chosen for analysis because they represented a cohesive, consistent data source that allowed for a structured entry point into the information to be collected over the next few years. The book response forms analyzed in this article were collected during the first year of the research study. The forms will continue to be collected and analyzed throughout the longitudinal study.

The research team developed the initial book response form in the summer of 2003 as a mechanism for collecting preliminary exploratory data from the children during the study's first year. The form was introduced to the children by members of the research team as a pleasurable recreational activity. It was emphasized that the children's reviews would be of benefit to other children who visited the collection. The children were asked to review the books in the ICDL the same way a movie critic reviews movies. They were told that the data from their completed forms would then be transferred to the ICDL to help other children select books to read. The children were asked to independently select, read, and review four books from the ICDL each month. They could read different books each month or the same book multiple times. The children were free to read books written in any language. They also were free to complete their review in their mother tongue (native language) or English. During the first year, all of the children chose to review the books they read in English. The children completed a one-page "book review" or response form for each book.

The book response form was made up of five short sections. The first section collected information about the reader and the book: name of respondent, date, book title and author, and how many times the child had read that particular book. The second section of the form asked the child how the book made him or her feel. Here, the reader selected one or more of five identified feelings: *happy, sad, scared, funny,* or *other.* The feelings listed on the form had been identified by the members of the Maryland KidsTeam as the emotions that they most often felt when reading books. The *other* category was added for this study to enable the children to specify additional emotions that they may have experienced when reading. The third section of the book response form asked the child what the book was about—the most common response was a summary of the text. The fourth section asked children to rate the book with three, four, or five stars. The fifth and final section of the book response form, which will be analyzed in a future paper, asked the child to identify a book that he or she would add to the digital library. The response form is reproduced in Figure 1 of the Appendix.

The response form was available in both electronic and paper forms. The children in Germany, Honduras, and New Zealand completed the forms electronically using a word processing program. Due to the children's

need for significant guidance from the library media specialist, children in the United States most often completed their response forms on paper. In all of the sites, the children submitted their completed forms to the teacher or library media specialist each week. Once a month the teacher or media specialist compiled the book responses for the month and sent the forms via e-mail or postal mail to the team in Maryland.

Data Analysis

Content analysis was used to analyze response forms from the twelve children in four countries. Dale (1989) explains that content analysis enables the systematic examination and evaluation of text or media in order to ascertain its meaning or possible effects. In the content analysis method, materials rather than people are examined, so the research is often replicable with the same data set. This technique applies the quantitative technique of frequency analysis to summarize qualitative data that result in "quasi-statistics," from which inferences can then be drawn (Maxwell, 1996). While the twelve-child sample is too small to allow generalizations to be made regarding differences among cultures, it was possible to identify differences and similarities among the diverse children in the study.

To analyze the book review forms, it was necessary to define what constituted a response. In 1972, Purves and Beach explained that "[r]esponse consists of cognition, perception, and some emotional or attitudinal reaction; it involves predispositions; it changes during the course of reading; it persists and is modified after the work has been read; and it might result in modification of concepts, attitudes or feelings" (p. 178). Extensive research analyzing children's responses to literature has been done in the education field. Thus, reader-response theory served as the framework used to analyze the book response form data.

Reader-response pioneers Purves and Rippere (1968) developed a scheme called *Elements of Writing About a Literary Work* to enable educators to analyze the types of responses readers have to literature. The scheme includes four major categories: (1) engagement-involvement, (2) perception, (3) interpretation, and (4) evaluation. This study used the Purves-Rippere schema combined with clarifying information from Odell and Cooper (1976) and Probst (2003) to analyze children's responses to the books they read.

Each form was coded twice by a single member of the research team and reviewed by at least one other. The forms were coded first for feelings and ratings data and then again for reader-response data using the Purves and Rippere coding scheme. Due to the completeness of the compiled scheme, the need for additional codes did not emerge from the data. The table in the appendix presents the coding scheme along with examples of how each code was applied.

Table 2. Total Year-One Book Reviews

Country	Dates	Number of Reviews
Germany	November 2003–May 2004	52 (23%)
Honduras	October 2003–May 2004	76 (33%)
USA	July 2003–May 2004	64 (28%)
New Zealand	November 2003–May 2004	49 (21%)
Total Reviews: 241		

Findings

From July 2003 to May 2004 the children in this study read 241 digitized books, that is, they had 241 reading transactions during the first year. Table 2 shows that the number of responses submitted by site was similar, each site contributing about 25 percent of the total 241 responses.

The 241 completed forms each yielded five responses—one from each section. However, only three of the five sections were analyzed for this article. Responses to the first section of the review form were not analyzed because the information given was primarily used to identify the respondents and to connect the book to the review (for example, author and title information). The final section of the review form, which asked the children to identify books that they would recommend be added to the digital library, will be discussed in a future paper that will address the globalization and commercialization of children's literature. If each child had submitted one and only one response in each section, the total number of responses would have been 723 (241×3); however, in some cases the children gave multiple responses in a single section. Therefore, 804 usable responses from three sections of the response form were analyzed for this article. The results from the second (*feelings*) and third (*ratings*) sections of the form are presented first, followed by an analysis of the responses based on the reader response coding scheme.

Feelings

Overall, happy (38 percent) and funny (39 percent) were the feelings most often selected by the twelve children. The least-selected options in the feelings category were scared (2 percent) and sad (14 percent). Antonio,[1] a boy from Honduras, shared his thoughts on a counting book in which the main character shares and counts her favorite foods, entitled *Counting to Tar Beach* (Ringgold, 1999): "This book is about a family who goes to a picnic and start [*sic*] counting the things they brought. The book is fun!" (Antonio, November 20, 2003).

Several children wrote about *Blue Sky,* a powerful story about a little girl who loses her parents and is alone in the world but later is reunited with her mother in heaven (Huseinovic, 2001). The children reported that this book made them feel both happy and sad. A girl from New Zealand clarified, "[This book makes me feel] happy and sad because at the start

the girl is lonely and nobody loves her, and that's why it's depressing, but then she finds her mother among the clouds and then that really finishes the story off . . . I like that I have mixed emotions at different times, and the pictures really draw you in" (Caroline, December 5, 2003). Other children shared the different emotions they felt after reading *Blue Sky*. Some did so only through their ratings, while others shared comments in their writing. Maata, also from New Zealand, wrote: "This book makes me feel sad because the little girl's mum died. Happy because the little girl gets to see her mum again" (Maata, January 21, 2004). A boy from Honduras responded, "This book is about a girl who was lonely and only drew blue pictures" (Juancarlos, March 18, 2004).

Children used the *other* category twenty-seven times (11 percent). Feelings added included *joyful, annoyed, bored, interested, touched, nervous, silly, hungry, crazy, amused, weird,* and *curious*. Arcelia, a girl from Honduras, mentioned that the book *Blue Sky* made her feel blue as in sad but also blue as in the color blue. There was little differentiation among the children within a site regarding the feelings that they applied to the same books. The most noticeable difference to emerge among sites from the feelings data was the slightly higher number of books rated as *sad* by the children in the United States. This finding is discussed later in the article.

Ratings

The children were asked to rate the books with three, four, or five stars. The ICDL research team chose to allow only the three highest ratings to be applied by the children in the study because the books in the collection had already gone through a rigorous selection process developed by the ICDL advisory board (University of Maryland, 2002b). Five stars corresponded to books the children thought were exemplary and those they would recommend to their friends. Four-star books were ones they would recommend but were not as good as five-star books. Three-star books were good but not good enough to recommend to a friend. The children rated most of the books in the ICDL collection with four or five stars.

Over half of the books selected and read were rated with five stars, followed by 33 percent that were given four stars. Only 34 books of the 241, or 14 percent, were given the three-star rating. Caroline gave three stars to a historic book from the collection: "[This book made me feel] happy because Richard finds many a friend, including a lady friend. [I would rate this book with] three stars because it doesn't really interest me with the characters and plot" (Caroline, February 18, 2004). Books that were given low ratings usually did not appeal to the child's particular tastes. Ojas, a New Zealand boy, knew the story he read was important because it taught a lesson, but he did not find the story itself to be interesting. He wrote: "[This book makes me feel] happy because the girls learn to get on with one another. [I would rate it with three stars because] it was all about

Table 3. Feelings and Ratings

Site	Happy	Sad	Scared	Funny	Other	3 Stars	4 Stars	5 Stars	Total Responses	% of Total Responses
Germany	24	4	0	21	7	11	18	21	52	22
Honduras	30	8	0	32	7	7	28	42	76	32
New Zealand	32	9	2	5	6	12	23	14	49	20
USA	6	13	4	35	7	4	11	48	64	27
Total	92	34	6	93	27	34	80	125	241	100
	(38%)	(14%)	(2%)	(39%)	(11%)	(14%)	(33%)	(52%)		

teaching a moral but was not a very interesting story" (Ojas, January 16, 2004). Table 3 presents the feelings and ratings data from each country. The children in New Zealand and Germany were less likely to give the books they read a five-star rating than the other children. The children in the United States and Honduras were more likely to apply the five-star rating than the three- or four-star ratings.

Reader Response

After sections two and four of the forms were coded, reflecting the feelings and ratings data, they were re-analyzed according to Purves and Rippere's Reader's Response scheme. (More detailed information about the scheme is provided in Table 1 in the Appendix.) The second section of the book review form asked the children to indicate how a book made them feel. The responses in this section were analyzed reflecting Purves and Rippere's *Reaction to Content* (PC) category, in which the reader gives a statement reacting to the work and his or her feeling about the work. The PC response was used on 239 occasions, or 30 percent of the total. This response type was evenly distributed across all four countries. Children also went beyond checking off boxes or writing one-word responses when they added statements such as, "this book is a whole lots [*sic*] of poems and they are funny" (Safara, January 31, 2004). Safara, a girl from Chicago, read and re-read a series of poems about life in Singapore by Choo and Yee (1996a, 1996b, 1997). One boy in New Zealand explained how he felt about *Shark God* (Martin & Shannon, 2001), a book about a family that saves a shark and is in turn saved from an evil king by the Shark God. He explained, "This book makes me feel happy because everything turns out well for the children and there [*sic*] parents" (Ojas, November 28, 2003). Affective responses to the books were frequent and ranked among the top three response types, along with *narrational* and *appreciation* responses.

The third section of the response form asked the children to tell what the book was "about." The resulting text summaries fell into the *Narrational Reaction* (DN) category of the coding scheme. The DN category was used on 241 occasions, or about 30 percent of the total. This response type was distributed evenly over the four countries. Responses in this category ranged

from a few words—"The play tells different lessons" (Arcelia, December 28, 2003)—to longer plot summaries. Children were not restricted to reading books written only in languages in which they were literate. For example, Arcelia, who speaks English and Spanish, read *Sei Chi'mupanze Ane Mhanza* (Mbarga & Ndhlovu, n.d.), a book from Zimbabwe written in the Shona language. Although she could not read the words in this book, Arcelia wrote an extensive summary about this story and rated it *funny*. Her description of the story was based solely on her "picture walk" through the book and her interpretation of the narrative through the illustrations. The children frequently gave *narrational* responses.

Children were asked to rate the books in the fourth section of the response form. They could rate books with three, four, or five stars. In this case, the rating of books corresponded to the coding scheme's *Appreciation* (EA) category, in which the reader gives an affective evaluation of the work, expressing likes and/or dislikes. In response to a Croatian book about life on a small island, Ojas said: "This book was hard to review because it was in a different language and the pictures were messy and hard to understand so they were no help" (Ojas, November 6, 2003). Responding to *Iguanas en la Nieve y Otros Poemas de Invierno* (Alarcón & Gonzalez, 2001), a book of bilingual English and Spanish poetry about winter, Caroline wrote: "This book made me feel funny because the poems made me laugh out loud, and I liked trying to read the English poems in Spanish" (Caroline, December 5, 2003). Children sometimes rated books with more than one rating category. For example, after reading *Where's the Bear?,* in which children identify animals and read the animals names in English, French, Spanish, German, Italian, and Japanese (Bruegel, 1997), Antonio explained, "I would rate this book three stars and four stars" (Antonio, January 23, 2004). He was not completely sure about which rating to give the book and therefore chose to give multiple ratings. As was the case with dual *feelings* rating, this type of dual star rating response was common. Table 4 gives a summary of the reader response data.

Table 4. Summary Analysis of Responses

Site	Total Reviews	%	PP	PC	DN	DL	DG	IE	IC	EA	ET	EV	MU	Total Responses	% of Total Responses
Germany	52	22	1	51	52	0	0	4	0	51	0	0	0	159	20
Honduras	76	32	0	76	76	0	0	5	0	76	0	1	0	234	29
New Zealand	49	20	3	48	49	5	2	15	5	49	26	14	0	216	27
USA	64	27	0	64	64	0	0	2	1	64	0	0	0	195	24
Total	241	100	4	239	241	5	2	26	6	240	26	15	0	804	100

Note: PP—personal statement; PC—reaction to literature; DN—summary or retelling; DL—description of aspects of the work; DG—interest in genre; IE—interpretation of parts of the work; IC—interpretation of the whole work; EA—affective evaluation; ET—statement about the construction of the work; EV—statement about the meaningfulness of the work; MU—unrelated.

Discussion

Overall, the response form data showed that children had multiple feelings during reading transactions; book ratings were likely to be high (five stars); and *Reaction to Content* (PC), *Narrational Reaction* (DN) and *Appreciation* (EA) responses dominated the types of responses children gave. In this section the reader-response data are analyzed to isolate possible factors that contributed to the previously identified patterns.

Feelings

The data showed that children participating in this study from all four countries often experienced more than one emotion when reading a single book. This finding suggests that the children in the study have multiple feelings during reading transactions and are aware of those emotions, which is consistent with Sebesta, Monson, and Senn's (1995) work showing that multiple meanings or, in this case, feelings, can emerge from one interaction with a text.

As noted above, the categories that children from all four countries used least were *scared* (2 percent) and *sad* (14 percent). The *scared* feeling usually was selected when the main character of the story was "doing something wrong" or was in danger. One girl explained that the book *Prietita and the Ghost Woman* (Anzaldua & Gonzalez, 1998), a story referencing the tale of La Llorona, made her feel "scared because a girl has to go into a forest where they shoot trespassers and you keep thinking she's going to be shot" (Caroline, December 5, 2003). *Sad* was used primarily for stories that started out sad but ended happily. The limited use of *scared* and *sad* ratings was consistent across all four of the study sites; however, child participants in the United States were more likely than the children in other sites to apply the *sad* rating to books they read. This finding could stem from the fact that the children were permitted to read books more than once. At the U.S. site Chalondra chose to read books that she categorized as sad multiple times. For example, she read *Blue Sky* more than once. From the data collected during the initial year of the study, it was not possible to determine whether she read *sad* books multiple times because she enjoyed the stories or if something more substantial was happening during her reading transactions. Chalondra's pattern of re-reading sad books, and the limited use of the *scared* and *sad* feelings in general, will be more deeply explored in the future years of the study.

Ratings

The children participating in this study were most likely to rate books they read with five stars, the highest rating possible. However, one boy wrote about the book *Sunflight* (McDermott, 1980), the story of Icarus's legendary flight and fall from the sky, "I would rate this book three stars, because it gets really boring because it's a legend, and I don't like legends" (Ojas, March 31, 2004). The children rated a book with three stars when they considered

it too easy or poorly written or illustrated, or when the book did not meet their expectations: "[I rated this book] 3 stars, because it is quite funny, but I expected more from this book because of it's [*sic*] amusing cover" (Caroline, March 21, 2004). The data suggest that when rating books the children considered elements beyond the story and the illustrations. They included their personal preferences, interpretations, and expectations of the book and included whether or not those expectations were met.

Reader Response

Two factors appeared to contribute to the types of responses the children gave after each reading transaction: the book response form and adult mediation. Preliminary research suggests that, even when children are given specific directions for a task, such as that provided by the response form, an adult can mediate or modify that task, thereby changing the types of responses the children give.

The first factor was the book response form. The most frequent response types given from all four countries were those explicitly requested by the form, which asked children to select or write how a book made them feel, write what the book was about, and rate the book using a star system. Responses to these three questions accounted for 90 percent of the 804 responses given. Surprisingly, *Explanation* (IE) responses were given when children wrote about individual characters to whom they could relate. This type of response was common among all four country sites and was not solicited on the form.

The second factor influencing the types of responses children gave was adult mediation, or the presence or absence of an adult when completing the response form. In New Zealand a classroom teacher was the primary contact; he incorporated the response forms into his language arts classes as an ungraded activity. Because of this integration and increased adult involvement, the responses from the New Zealand children were richer, or more in-depth, and provided more insight into why the children applied the ratings they chose. Hynds (1989) observed that the amount and kind of response a child gives is greatly influenced by the amount and strength of support and encouragement he or she receives at home and in school. Adult mediation and participation during response helps children think more critically about and respond more deeply to literature read not only for graded assignments but also for recreation. Based upon these preliminary findings from year one of the longitudinal study, the following changes will be in place for year two.

Future Research

While many logistical practices, such as the manner in which reviews are submitted, will remain the same, year two will bring changes in both the book selection and response processes.

Selecting Books to be Reviewed

As reported in the methodology section, when the children in this study responded to the same book, they exhibited multiple perspectives. For example, seven children read the collection of poems *Whose Cat Is That?* (Choo & Yee, 1997). The children responded in a relatively consistent manner within sites, but there were differences between children in different sites. These similarities and differences suggest that there may be much to learn when the children all respond to the same book. The aggregated responses may provide a venue through which international patterns may emerge. Based upon this possibility, the book selection process for year two has been modified.

Over the course of seven months, each child will respond to fourteen books by completing fourteen response forms. The number of books the children will respond to has been reduced from four per month to two per month so that children will be able to spend more time engaged with the literature—thinking, writing, and drawing in reaction to what they read. Each child will select seven books ("reader's choice") to read and review. The remaining seven books will be identified by the researchers (preselected). None of the books will be used in conjunction with school assignments.

The self-selected, or "reader's choice," books will be any book from the ICDL collection that was added after the first year of study. The seven preselected books will be identified by the research team from the books added to the ICDL collection after the first year of the study. Through this modification the research team believes that it will be possible to more clearly identify both similarities and differences among individual children in various locations and similarities and differences in responses among the four sites.

Responding

After reading each book, the children will respond to three prompts:

- Write what you think is most important about this book and why.
- Write what you think or feel about the book and why.
- Draw a picture about what you read or how you felt after reading the story.

The children's responses will continue to be collected electronically in most of the locations. The form/writing part of the reviews will be done online in Germany, Honduras, and New Zealand and on paper in Chicago. The children will continue to report feelings and ratings data, as well as summary information about the book; however, rather than describe what the book was about, they will be asked to describe what was most important about the story. The children's drawings will be done on paper, then

scanned and sent electronically to the team in Maryland. The drawings will be analyzed as part of the overall book response. The team expects to learn more about how children felt about and responded to the book through the drawings, especially since the children are at an age where they are often better able to communicate their thoughts and feeling through drawings than in writing. Combined with the oral communication taking place between the children and the adult participants, it should be possible to triangulate data collection and develop a clearer picture of the children's thoughts and feelings during the response process.

For year two the use of adult intermediaries after the reading transaction will be encouraged. Adults will be asked to play an increased role in the research by providing a time and space for reflection, encouraging the sharing of ideas about the books read in the school and home environments, and encouraging the children during the response process. The expected result will be increased guidance for the children when they encounter difficulties in explaining their thoughts to others. Having an adult available will increase the amount of oral communication taking place during the review process. Adults will have the option of acting as note takers (typing or writing for the children) and will be available to ask questions to help clarify the children's thinking.

It is expected that, with fewer book responses required, open-ended prompts, and increased adult participation, the children will explore the literature more deeply, giving greater insight into how they feel about the books and what they consider most important during the reading transaction. These changes in data collection should greatly increase the richness and depth of the data pool generated for this research.

Conclusion

The preliminary results of this study reflect the findings of past reader-response theorists. Even though this study was conducted using digital materials, similar findings emerged concerning the power of task and adult mediation and the experience of multiple emotions during the reading transaction. These findings serve as the foundation for the revised data collection plan for year two and a continuing exploration of children's recreational reading responses and international patterns in those responses. Although there is a long history of reader-response research in education, the library and information studies field is just beginning to investigate children's responses to literature. Overall, little research has explored recreational reading or similarities and differences that may exist here and abroad in children's reading responses. This line of research has implications for better defining library services, programs, and collections that more clearly respond to the interests of children.

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Note

1. The children's names have been changed for privacy purposes, but they were given pseudonyms from the country they represented.

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Appendix

Name:
Date:

Digital Library Book Review

Title:

Author:

Is this the first time you have read this book? Yes No

How many times have you read this book? time(s)

This book makes me feel (choose one):

Happy Sad Scared Funny Other:

This book is about:

I would rate this book (choose one):

If I could add a book to the digital library, I would add:

Appendix Figure 1. Longitudinal Study Book Review/Response Form

Appendix Table 1. Reader-Response Analysis Scheme

Code	Sub Code		Definition/ Scope Notes	Example
Personal Response	Personal Psychological	PP	A statement about the reader, an autobiographical digression; associational, self-reference; comments about one's self, personal statement; refer to one's associations; directed away from the work toward the reader's context, memories, friends, etc.	"This book makes me feel happy because listening to poems make [*sic*] me feel happy and smile with joy." (PC, PP)
	Reaction to Content	PC	A statement about the work, expressing personal engagement with it; reaction to literature, reaction to issues raised by the literary work; refer to one's feelings about the work and one's relation to it; directed at the work and the reader's feelings about it	"This book makes me feel amused because I enjoy how the hare does all this hard work to not get caught, but he does." (PC, IE)
Descriptive Responses	Narrational Reaction	DN	A retelling of part of the work; statement of facts, quotations, summary of content; description of the work	"This book was about animal poems, food poems and flat poems." (DN)
	Perception of Language	DL	A description of aspects of the work (language, characters, setting, etc.); perception of formal literary devices (structure, tone, rhyme, repetition); description of the work	"I didn't think this book was very good, partly because I didn't really like the plot and partly because I don't think it [*sic*] very well written." (EA, ET, EV)
	Classification by Genre or Context	DG	Noted interest in a specific genre	"[This book] gets really boring because it's a legend, and I don't like legends." (EA, DG)
Interpretive Responses	Explanation	IE	An interpretation of parts of the work; focus on the text; use of experience to explain behavior, interpretation of significance of a literary work, explaining characters, phrases, and other parts of the work; specific interpretation, explaining characters, phrases, and other parts of the work	"I really liked reading about the old man's point of view." (EA, ET, IE) "I like Axle and I think it's sad how he doesn't have much [*sic*] friends." (IE)
	Content-Ideational	IC	An interpretation of the whole work; focus on the text; generalizations drawn from facts, interpretation of significance of a literary work; general interpretation explaining the whole work	"[This is an] extremely cute book with a sweet ending." (IC, EA, ET)
Evaluative Responses	Appreciation	EA	A statement about the evocativeness of the work; like-dislike, affective evaluation; evocative power of work–can be positive or negative	"This book was hard to response because it was in a different language and the pictures were messy and hard to understand so they were no help!"
	Technical-Critical	ET	A statement about the construction of the work; evaluation of method; power of the construction of the work--can be positive or negative	"[This book] doesn't really interest me with the character and plot." (EA, ET)
	Evaluation of Author's Vision	EV	A statement about the meaningfulness of the work; evaluation of the meaningfulness of a work--can be positive or negative	"[This book] describes what happens and . . . it has a lovely ending." (ET, EV)
	Unrelated	MU	Unrelated, incomplete verbalization	N/A; Never used

Educational Inquiry and Creativity: Developing Digital Resources in Ireland's Information Age Town

Claire R. McInerney

Abstract

Despite cultural and social barriers to technology adoption, the teachers and administrators of schools in the Irish town of Ennis, with help from the Clare County Education Centre, integrated computers, networking, software, Internet, and digital imagery into the schools' curriculum. Success in technology integration has been achieved in primary education due to persistent and innovative efforts on the part of teachers; however, technology integration has not been as deep nor as broad in the secondary-level schools. Students have produced many new learning materials themselves using computer-based tools, the Internet, and other technologies. The barriers, challenges, and achievements of the community described in this case study may have implications for other small communities who wish to use technology for teaching, learning, and curriculum change.

Introduction

> As teachers move away from the lecture method to viewing students as active learners and providing for their learning needs in new ways, technology will become a natural and integral part of the classroom, just as it is in everyday life. (Matusevich, 1997, p. 147)

In 1997 when Ennis, Ireland, won the competition to become Ireland's "Information Age Town," there were virtually no computers in the schools, and very few teachers had ever personally used a computer. For the most part, educators were skeptical that technology would change traditional teaching and learning practices. This article documents the changes that have taken place since then, with emphasis on the integration of technology into the school curriculum, the efforts taken by teachers to make this happen, and examples of how students constructed their own digital learning materials.

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Background

Historical Context

Ennis, a town of 18,000 people located in the west of Ireland, was named Ireland's Information Age Town in 1997 after a spirited competition among forty-six Irish towns. Ennis had not experienced the technology and financial boom, usually referred to as the "Celtic Tiger,"[1] that other, more urban areas of Ireland had celebrated in the mid-1990s; thus, being named the Information Age Town (IAT) promised to move the town rapidly into the information society (Bangemann, 1994; Castells, 2000; Feather, 1994; Information Society Commission, 2002; Komito, 2001; O'Donnel, McQuillan, & Malina, 2003).

Eircom, the telecommunication firm that sponsored the Information Age Town contest, articulated two goals: "1. To saturate a town with 21st century communications technology and see how people come to terms with such technology. 2. To encourage the town to trial new technologies and applications" (Ennis Information Age Town, 2005b). Education was one of the sectors included in the attempt to infuse the community with computers, software, network technology, and training so that the entire town could become computer literate and benefit from the new tools available to virtually all town residents.

In 1997 Ennis was a busy county market center with a good school system, but there was little technology awareness and use. Even to supply homes with Internet access, the IAT staff first had to provide phone service to six hundred households (Behaviour & Attitudes Marketing Research, 2001, p. 10). Schools were not quite prepared for the loads of computers, monitors, and peripherals that were delivered to their doorsteps (McInerney, 2003). Space had to be found for the equipment, furniture had to be ordered for computer rooms, teachers needed computer training, and lessons needed to be revised if the technology were to be truly integrated into the curriculum. The price tag for the Information Age Town endeavor (1998–2003) was 19 million with 1.9 million of that amount devoted to education (McQuillan, 2000, p. 27; Ennis Information Age Town, 2005a). For a town in the mid-west of Ireland, this was a huge investment; the enormity of the possibilities was not lost on the town's teachers. The purpose of this article is to report on a study that investigated how educators incorporated new technology into the curriculum in the context of a networked community and to highlight projects where students created their own learning materials.

Networked Communities and Education

Rural and remote communities are often those most disadvantaged in the accessibility of information and communication technologies (Marshall, Taylor, & Yu, 2003). The Ennis schools did not have that problem

despite their rural surroundings and isolation from Ireland's major urban centers. Like other educators in networked communities, though, the Ennis educators confronted the challenge of how to best take advantage of the technologies for learning, a challenge more daunting than acquiring hardware and software. A similar situation faced the teachers in the Montgomery School System affiliated with the Blacksburg, Virginia, Electronic Village (BEV) project during the mid-1990s. The BEV educators found that, before using Information and Communication Technologies (ICTs) in the classroom, it was necessary to adopt learner-centered or constructivist models of education (Ehrich & Kavanaugh, 1997).

In considering models and methods to use in the continual adoption and integration of ICTs, the Ennis educators concentrated on active learning, social interaction, and inquiry-based cognitive learning and teaching, but they needed firsthand knowledge about technology before implementing any of these strategies. In a study of networked communities commissioned by the Rand Corporation, training was viewed by all interviewees as a critical first step to helping individuals go online (Anderson, Bikson, Law, & Mitchell, 1995). Training emerged as a key factor in implementing technology use in Ennis as well. Subsequent sections of this article will discuss educators' adoption of technologies and how they used new-found knowledge to enhance and, in some cases, change the curriculum.

Research Methodology

An investigation of the Ennis schools' integration of technology was a multimethod study where researchers spent extensive time in the Ennis community. It is part of a long-term community informatics study that focuses on various community sectors (Business, Education, Nongovernmental Organizations [NGOs], Public Service, etc.) as the units of analysis. "Community Informatics" (CI) is a relatively new field that studies

> the practice of enabling communities with Information and Communications Technologies (ICTs). CI seeks to work with communities towards the effective use of ICTs to improve their processes, achieve their objectives, overcome the "digital divides" that exist both within and between communities, and empower communities and citizens in the range of areas of ICT application including for health, cultural production, civic management, and e-governance among others. (Journal of Community Informatics, 2000)

The intention of the research is to create case studies of each sector of the community. The ongoing study began in 2001 and, although educators have been interviewed throughout the course of the research, the Ennis education sector was the primary focus of research during the fall of 2002 and winter and spring of 2003. A detailed timeline with a list of research methods and participant groups is given in Table 1.

Table 1. Summary of Research Methods with Sector Participants in the Ennis Study

Timeframe	Method	Sector	Number of Participants
May 2001	Interview	Ennis IAT Staff	7
	Interview	Entrepreneurs	2
	Interview	NGO—Regional Development Organization	1
	Interview	NGO—Chamber of Commerce	1
	Interview	Business	3
	Interview	Education	6
	Interview	Public Service—Library	2
March 2002	Interview	Ennis IAT Staff	1
	Interview	Business	2
	Interview	Education	1
	Interview	Public Service—Library	1
October–November 2002 (Three Visits to Ennis)			
	Interview	Ennis IAT Staff	3
	Interview	Education— Principals, Technology Teachers	21
	Interview	Residents—Parents	3
	Interview	Entrepreneur	1
	Group Interviews (2 sessions)	Education—Teachers	16
	Self-Administered Survey Distributed in Hard Copy to 360 Teachers	Education—Teachers (45% response rate)	162 respondents
January 2003	Interview	Education—Principal	1
	Group Interview	Education—Teachers	7
	Group Interview (2 Sessions)	Education—Students	8
	Interview	Residents—Parent	1
December 2003	Interview	Ennis IAT staff	3
	Interview	Entrepreneur	1
	Interview	Education	1
	Interview	Public Service—Library	1

Research Questions

The research questions that guided the study sought answers to the following:

- What was the level of ICT use in the schools?
- What processes were used to integrate ICT into the curriculum?
- What were the experiences of the teachers and principals in regard to learning and teaching with technology?
- What were the lessons learned from the Ennis schools' experience?

Research Methods

A literature review focusing on studies of networked communities and educational technology began the process. Issues of the *Irish Times* and the

local newspaper, the *Clare Champion,* were searched electronically for articles about the Information Age Town. Documents from the Irish Department of Education and Science were read, and the Web site for Ennis as well as those for each Ennis school were examined. In addition to individual and group interviews, self-administered surveys were distributed to 360 teachers in Ennis, with 45 percent of the town's teachers completing them. The results of the survey were entered into SPSS with subsequent reports generated from the software. The purpose of this article is to report on the qualitative aspects of the research. The quantitative results are reported in "Wired Ennis: Learning and Technology in an Information Age Town" (McInerney, 2003).

Participants

The principal investigator, an information scientist, visited Ennis seven times, spending weeks at a time in the community and a total of thirty-five hours observing in the Ennis schools. She conducted interviews with an array of key individuals and groups, including the principals of thirteen Ennis schools, eight school technology coordinators, parents, teachers, public library administrators, entrepreneurs, business people, public service individuals, and Information Age Town staff members. Another researcher, an educational psychologist, interviewed students, Information Age Town staff members, one parent, and one principal. The two researchers together conducted interviews with several individual principals and the director of the travelers' education center. The interviewers asked subjects for forty-minute interviews; however, most of the interview sessions lasted for an hour or more.

Researchers used prepared protocols in the semistructured interviews in order to be consistent in the questions asked within categories of informants. The questions covered standard demographic information; attitudes toward technology; technology diffusion, adoption, and use; impact of the Information Age Town project on teaching and learning; infrastructure; technology support; barriers to learning with technology; and general open-ended questions to allow for unique comments on the part of interviewees. Throughout the course of the overall project, ninety-four people were interviewed, with some key informants being interviewed multiple times. Key informants included the Ennis Information Age Town Director of Research, director of the Clare Education Centre, an Ennis entrepreneur, and a technology teacher. In the education sector, during the 2002–2003 period, 162 participants responded to the survey instrument, and 58 individuals participated in interviews.

Because interviewing was critical to learning about technology in the schools, great care was taken in analysis and coding of the interview transcripts. All individual and group interviews (with one exception) were tape recorded and transcribed verbatim, and the transcriptions were coded

Table 2. Interview Codes for the Ennis Information Age Town Schools Project

Code	Meaning
Apps	Key applications in the schools (Internet, Word, etc.)
Attitudes	Teacher, administrator attitudes
Barriers	Barriers encountered
Best	Best practice
Curric	ICT as cross-curricular tool
E-mail	E-mail use in schools
Factors +	Factors that encourage ICT use
Factors -	Factors that discourage ICT use
Future	Schools' future plans
Gaps	Gaps in existing technology solutions
Home	Home-school communication
Infra	ICT infrastructure (hardware, software, etc.)
Inter	Interschool projects, policies
Irish	How best to use technology to benefit Irish education
Learn	ICT used for learning, new learning
Lessons	Lessons learned
Level	Level of usage
Manage	Use of ICT to administer or manage Policy Schools ICT policy recommendations
Projects	ICT projects
S-skills	Student skills development
Space	Physical space for computers
Special	Special needs, assistive technology
T-skills	Teacher skills development
Tech	Technical issues (maintenance, support, networks, etc.)
Website	Role of school Web site

using Grounded Theory methods (Strauss & Corbin, 1998). Consistent with Grounded Theory, the researchers performed open coding, that is, reading each transcript and ascribing subject categories to each paragraph. After reading all transcripts and analyzing the categories, the keywords were synthesized into a list of categories related to the research questions. Axial coding produced the categories listed in Table 2. All interviews were reread and coded using these categories. Interviews were transcribed by the principal investigator and three graduate students. Graduate students also assisted in coding fifteen of the educator interviews.

Researchers entered open coding categories and keywords into Nvivo software, running reports to assist with the content analysis of the interview transcriptions. The revised coding using the keywords along with a review of the Nvivo reports allowed the researchers to perform an analysis in order to make sense of what informants said about technology and learning in the Ennis schools. During visits to the primary and secondary schools, researchers were able to observe students in classrooms and computer labs for a total of thirty-five hours. These visits helped verify what informants had said in interviews as well as allowed us to see students and teachers in the context of their educational environment.[2]

Research Findings

Change Necessitated Learning: Teachers

In late 1997 the reality of receiving truckloads of computers, monitors, keyboards, and cables took educators by surprise.[3] By 2002, however, most of the primary schools (prekindergarten through eighth grade) had integrated the technology into the curriculum. Most primary school teachers say that the changes in the school have been "transformative," and they are surprised that they are now conversant with computers and understand how to use them for teaching and learning. When interviewed, teachers said that in 1997 and 1998 most had never touched a computer. They were "terrified," "frightened," and "extremely apprehensive" of computers, to use their own words, and they knew nothing about how to turn the machines on and nothing about how to teach with them. By 2003 many were routinely communicating with the principal by e-mail, and most, especially on the primary level, were comfortable with software and technology tools as part of the curriculum.

The changes that took place were the result of a patchwork of professional development: formal workshops, self-education, experimentation, and teacher-helping-teacher learning efforts. Workshops were organized by the Clare Education Centre, a county in-service teaching center, where the director had a personal interest in the success of technology in the schools. The appointment of technology coordinators for each school through an Irish Department of Education and Science program[4] (Galvin, 2002) was timely. These coordinators were given one-year appointments all over Ireland, but in Ennis there was a gold mine of technology with which to work. In other places the technology coordinators had to struggle to supply schools with computers and networking.

Teachers who lived in Ennis were able to apply for one of the many multimedia computers that were offered to residents of the town for £260 ($333) with an estimated value of £1,800 ($2,286) (Spellissy, 2003, p. 78). Even teachers who did not live within the town boundaries, but who taught in Ennis schools, were allowed to take advantage of the special low-cost computers, which included software, modems, and printers. In interviews many teachers mentioned that having their own computer allowed them to work in a private space until they felt comfortable enough to introduce a program in the classroom.

In the interviews conducted by the author, teachers demonstrated that they were creative and persistent in their determination to "tame the computer beast," as one of them said. Another teacher responded that, at the beginning of the project, the teachers were "as green as cabbage" regarding computing. The biggest motivation for teachers to learn about technology themselves was the realization that something new and potentially life changing was happening to the town, and they wanted to participate. One

teacher said, "Some teachers really had this vision that it was going to be a big thing, and they needed to be part of it." It was this vision that encouraged the teachers to employ a variety of strategies to learn themselves.

One of the more adventurous learning strategies was a "field trip" organized by nine of the teachers to the Education Technology Centre and three schools in Omagh, County Tyrone, Northern Ireland, where schools had a reputation for effectively integrating technology (Walshe, 2001, 2002). The goal of the visit was to see how the schools in Omagh compared with those in Ennis, using Omagh schools as a benchmark for Ennis. The UK had been equipping schools with software and computers since the 1980s, so the Omagh teachers were much more experienced than those in Ennis, and they were required to integrate technology into every class. The result of the trip was a heightened sense of self-confidence for the Ennis teachers because they saw some practices in place in Omagh that the Ennis teachers were using, even though technology in Ennis was still at a nascent stage. Another unintended consequence of the trip to Omagh was a feeling of closeness and connectedness among the teachers and an understanding that they would support each other in the future, especially with the task of selecting and learning new educational software.

As interviews with teachers revealed, though, it was the personal, gritty will of the teachers to use the technology to the children's advantage that made change possible. The teachers admitted "We were all beginners" in the early stages, but they started from scratch to select software, discuss curriculum changes, and learn about computing in a peer-helping-peer model. Teacher-learning efforts included

- enrolling in classes offered by the Ennis Information Age Town (EIAT) staff; the Schools Integration Project (SIP), a nationally funded program; and the University of Limerick and other universities;
- taking the European Computer Drivers License (ECDL) course;
- learning from the school-based SIP coordinator;
- participating in training offered by the Clare Education Centre;
- experimenting on a home computer;
- learning from a colleague.

Figure 1 summarizes these learning methods quantitatively, with data gathered from questionnaires completed by Ennis teachers.

Challenges and Champions

Teachers in Ennis committed themselves to change teaching strategies in radical ways. As teachers indicated in interviews, traditional teaching in Irish schools is conducted under a didactic model where teachers are those who have the knowledge and inform the students through lecturing and designing learning activities. Unfortunately, the didactic model is simply

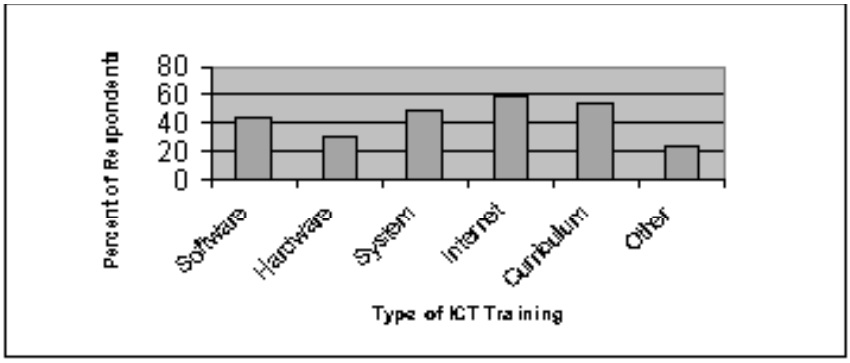

Figure 1. Types of Information and Communication Technology (ITC) Training in which Ennis Teachers Participated. Note: Numbers are derived from a survey distributed to all Ennis teachers.

not compatible with technology learning because, to use technology effectively, children must participate in inquiry, discovery, information seeking, and creative experimentation with various information resources (Berge & Collins, 1995; Ehrich & Kavanaugh, 1997). In confronting computing and networking, Ennis teachers were faced with a corpus of knowledge (how to use the technology) with which they were not only unfamiliar but actually feared. As Berge and Collins point out, in using technology "the roles of students and teachers will change. No longer perceived as the sole experts and information providers, teachers become facilitators and guides. Conversely, students are no longer passive learners, attempting to mimic what they see and hear from the expert teachers" (1995, p. 5). In Ennis, teachers would be called on to become technology coaches or guides with students who would take more responsibility for their own learning and constructing their own learning materials.

In observing similar challenges that faced teachers in Blacksburg, a small networked community in Virginia, Ehrich and Kavanaugh say:

> The need to transform pedagogy, to learn new technology, and to adjust to the challenges of teaching in a networked environment is but the beginning of the human problem for the teachers. Having taught with substantially the same style for many years, most teachers are not accustomed to an environment in which they must learn faster than their students and on their own time . . . After all, teachers want to focus on their educational agendas, and many view the need to deal with ASCII codes, broken cables, GIF files, and unusable freeware as an intrusion or a diversion of their energies (1997, p. 102).

How did most of the Ennis primary teachers overcome their technology reluctance and become motivated to take on the challenge of a new way of teaching? The answer points to several factors: technology champions, the culture of volunteerism, and pride in competition.

There were several "sparkplugs," or technology champions, who initiated change and were dedicated to seeing that technology change took place in the schools. In many ways these champions inspired the teachers to persist and learn. The Schools Integration Project director for the county organized and taught workshops; she helped organize the Ennis schools' technology coordinators, and took the lead in the teacher field trip to Omagh. The technology coordinators often embodied the spirit of excitement and doing something new, and, equally important, they were on hand in the schools to support teachers if they had problems with equipment or needed help with software. The director of the county education center was proficient with technology and supported training sessions by offering space and technical assistance. Other technology champions included several Ennis principals, one of whom was on the original town committee that presented the Information Age Town proposal to Eircom, and she continued to model technology learning, routinely sending out a daily email message to teachers. Two other principals were enthusiastic and encouraging, becoming computer literate themselves and working closely with the school's technology coordinator to ensure that progress was being made.

Having supportive principals and technology teachers certainly facilitated the availability of technology workshops for Ennis teachers during the school day. However, substitute teachers were scarce, so teachers had to learn about technology on their own after school and in the evening. One of the Information Age Town staff members, Sean (a pseudonym), explained why teachers were willing to put in extra time without explicit rewards, and his words were echoed by other town residents who were interviewed. He said that in the Irish culture volunteerism and competition are highly valued. Teachers volunteered to learn technology applications because they were accustomed to a culture of altruism. Sean indicated that much of the care of the elderly and other social services that would be institutionalized in the United States and other countries are carried out by volunteers in Ireland. In the United States teachers may have expected extra pay or time off to learn the new technology, but in Ennis many teachers learned and experimented on their own time. Some were able to take some time off during the day to attend training sessions at the education centre, and, while there was funding, substitutes were hired to take their place in the classroom.

Sean also said that "sport is taken very seriously here," pointing to the competition experienced in sports as a characteristic that pervades many aspects of Irish life. Both girls and boys are encouraged to join team sports and cooperate with the team and learn through competition. The Gaelic Athletic Association (GAA), as Sean pointed out, is the biggest organization in the country by far and hugely influential. Just as Ennis residents were proud of winning the IAT competition, the teachers would want to

Table 3. Summary of How Ennis Educators' Responses to Technological Change Paralleled Classic Change Strategies

Classic Change Strategy	Ennis Educators' Responses to Technology Opportunities
Provide awareness	Introductory workshops were held and newsletters distributed
Select those interested in change to pilot change	Information technology (IT) school coordinators were chosen
Train the trainers	IT coordinators attended regular meetings and took classes on software and hardware use, networking, and Internet applications. Coordinators then taught others in their own schools
Gradually add more people to the process as others see changes as successful	Teachers, principals, and the Clare Education Centre become partners
Use benchmarking to develop goals and objectives	A teacher group visited schools in Omagh, Northern Ireland, to learn about selecting educational software and teaching strategies
Ensure that there are well-trained champions who can sustain the change	At first the IT coordinators were the champions; when funding ended, volunteer IT champions were left to carry on

continue the pride by being a part of one of the biggest projects to come to the town, no matter how difficult that might be. Although many teachers said that they had worked in the Ennis schools twenty or thirty years or more and were well established in their teaching methods, they were still willing to change if it meant being a part of the new information society. Not all teachers signed on, of course, and at the time of the research in 2002, there were still a few in each school who refused to use computers in their classes. Unfortunately, those teachers were reluctant to be interviewed.

Ennis was a situation where change was thrust upon a social system, including the educational sector, and where educators responded by following a classic change process model. Table 3 spells out traditional change strategies and how Ennis educators responded using each strategy.

In the remarkable change process undertaken by the educators in Ennis, teachers adopted methods and a view of teaching that were closer to a constructivist paradigm and less didactic than before the influx of the technology tools. One educator told us, "Teachers need the three C's—a comfort zone, confidence, and commitment," and these three C's are somewhat dependent on each other. This sentiment is endorsed by O'Bannon and Judge, who remark that "Teachers must feel comfortable with technology before they can include it into instructional situations" (2004–2005, p. 198). Through a patchwork of technology training and self education, the teachers found themselves in a situation where fundamental change had taken place in most classrooms.

The following section of this article discusses examples of how, after being given access to digital materials, the children of Ennis created learning materials and began to create digital libraries for themselves and others.

Inquiry-Based Learning—Students

Merely investing in educational technology will not change education nor result in better learning programs. However, in the "largest community technology project in the world," as Ennis is reported to be (Ennis Information Age Town, 2005a), the opportunity to integrate technology tools in the schools became the impetus for allowing children to create and learn in new ways. As one veteran teacher said, "I think the Information Age Town has changed the face of the schools completely; it certainly has changed my life, and I think it has changed everyone's life who is involved in the schools." In Ennis, information technology champions (sometimes principals, sometimes teachers) devised new ways of teaching and learning.

Technology, Learning, and Young Children In Ennis, "infant" classes (four to six year olds) are introduced to keyboarding and using a mouse with age-appropriate software that relies on images, spoken words, and music. Children learn to follow the cursor and click to navigate through a program. As a pre-language exercise, children create their own picture books using image files and Microsoft PowerPoint. Although researchers saw no evidence of an archive of these works authored by children, one could be created on a school's Web site so that parents could access their own child's work and children themselves could track their progress as they move through the various levels.

In one school, as the six-year-old children learn the alphabet, become proficient on the keyboard, and acquire some language skills, they participate in an email exchange with their peers in Dublin. Mr. Seamus, a teddy bear, spends some time with the Ennis children[5] and then is sent for a stay with the class in Dublin. In this age-appropriate "Teddy on Tour" exercise, the children exchange messages to learn how Mr. Seamus is faring and what is happening around him, all of which encourages curiosity about another part of the country, teaches the usefulness of computer-mediated communication, and helps the children practice word recognition, spelling, and writing in general.

Technology Tools and Children with Special Needs Researchers found that children who have special needs (learning disabilities, autism, Down's syndrome, etc.) are among those in Ennis who use technology most frequently for learning. As one special education teacher stated, "We use it every day, all day. It is totally integrated in our curriculum for special needs children, especially those at a lower cognitive level." Children in the special needs schools and programs use talking word processing programs (Clicker-4, for example) and make extensive use of the digital cameras for creating stories and books.

An observer in one class in an Ennis school devoted to children with physical, learning, and other psychological disabilities was immediately struck with the ease and accessibility of technology tools, even for young

children. In an infant class, computers and monitors are scattered around the classroom on low tables, just the right height for four and five year olds. Headphones sit on the tables next to the computers. Digital cameras, resting in their cradles, are cabled in to the computers and ready for use. Children and teachers in this class take pictures of everyday activities, and teachers print out the color photographs. Each child has an activity book that goes home each evening and is returned in the morning, providing parents with daily communication from the school and a visual record of their children's progress in growth and learning. On its own, sending home photographs of the day's activities may not seem so unusual; however, the routine, personalized, daily use of the digital cameras in this way captures the immediacy of the learning and most certainly demonstrates an innovative means of school-home communication. In the long run, when Ennis educators seek to sustain their technology integration projects, the community will no doubt be called upon to support the purchase of software updates and new computers. The ongoing communication made possible by the technology tools may help in soliciting the support needed from parents, some of whom are influential community members.

The special needs children create stories, learning how to construct a narrative, just as the children in mainstream infant classes do. Images are embedded in the software, so even preliterate children can construct their own tales. Hyperstudio software and Storymaker assist the young story weavers, but it is the intellectual process of understanding the elements of a story, the development of a plot, creating characters, revelations and surprises, and then coming to a conclusion that helps the children become ready for reading on their own. One parent of a disabled child said that her daughter finds working on the computer more interesting, more fun, and more interactive than other ways of learning. Her daughter even tells her mother how to perform certain functions on the computer and encourages Mom when she succeeds by saying, "That's the way; now you've got it."

One educational challenge is teaching Irish to children with special needs.[6] One primary school uses a software package to teach Irish sign language to deaf children, and the children seem to enjoy the graphics and photographs on the CD. The problem is that Ireland is a small country, so there is no critical mass to buy software for children with special needs, thereby making it difficult for a software producer to make a profit. Teachers say that they would like to have the government subsidize the development of such educational materials so that the curriculum could be enriched with more interactive technology tools.

Curricular Innovations in Primary School Three projects stand out as particularly creative ways to use technology to encourage inquiry and fundamental research skills among children in primary school.

The West Clare Railway was at one time a narrow gauge railroad that

carried citizens of County Clare from Ennis to the coastal towns and back again. It was a critical transportation link from Ennis to outlying areas. Today, the legendary railroad exists in folk songs, plays, and personal accounts of a time when few had a car in County Clare. Although the railroad is no longer operational, children in schools where stations existed learned about their county's history (by researching original sources) in order to complete the explanatory text for the project. When a visitor clicks on the interactive Web site map, for example, on the town of Ennis or another town where the railroad stopped, information about the town and station are linked and made visible. The Web site presents a valuable historical record for anyone interested in the history of County Clare, whether in Ireland or the Irish diaspora, told in the words of the children who did the research and wrote the narratives.[7] The interactive Web site can be found at http://www.clare-education-centre.ie/projects/west-clare-railway/.

Traditional Irish music makes its home in County Clare, so it is not surprising that the music of Clare became a topic ripe for study and technology applications in Meet the Musician. The Clare Education Centre and the Traditional Music Archive (http://www.comhaltas.com/culturlann/ennis.htm) cooperated with the Ennis schools and others throughout the county to present biographies and music of local Irish musicians on the Web. The interactive Web site includes digital images, music, and stories about the musicians who call the county home. In order to populate the site with the narratives and sound clips, the students learn about the music and the musicians through an understanding of creating oral histories, learning interviewing and other research skills, writing up their results, and Web site development. This Web site is password protected, and, although available to students and educators, it is not publicly available.

Children from four to eleven years are also cooperating on a project called Birds in the School Yard, where children observe the species of birds that fly above and land in their school yard and keep track of the numbers of each species that they observe. They learn about the birds through literature and Web research and then write about them. Like the Clare Railway project, the work of all the children is being compiled and eventually will be posted on an interactive Web site that will link pictures of the birds to the children's descriptions of what they have observed and learned.

One can see a theme among these three projects of interschool learning in various disciplines, including history, zoology, music, etc. They all focus on local phenomena and primary and secondary research methods, with students analyzing and writing about the results of research, and the end result being learning products captured digitally on hyperlinked Web sites. The children not only learn, they create lasting learning products that can be archived and reused, forming the basis of ongoing digital libraries of locally researched material. Using the Web technology, all the students and, in fact, the community can benefit from the learning that has taken place.

Secondary School Curriculum Computing is not ubiquitous in Ennis' secondary schools; however, great strides have been made, and slowly technology is being incorporated into the learning activities. One coeducational secondary school of 960 pupils received 68 computers from the EIAT. However, this school has seen a 32 percent increase in enrollment over the past ten years and, even with this equipment largesse, it was hard-pressed to meet the needs of all students. In order to accommodate the demand, a new building was constructed in 1998 with two technology labs equipped with computers, video conferencing capability, and multimedia projectors for an optimum teaching environment. An extension is needed now and will be built in the near future.

Science teachers wanted to integrate ICT into course learning. Consequently, they worked with students to establish a collaborative project using "First Class" groupware. The EIAT provided a server so that students in a number of high schools in Ennis could work together via First Class. Three of the four secondary SIP coordinators had a science background, so the integration of IT and science was a natural venture. The four SIP coordinators met once a week at the Clare Education Centre to receive training from EIAT staff in First Class, to plan the project, and to monitor progress. Each student was given a password, so they were able to enter the Ennis network and talk with each other on the First Class platform.

Students were able to choose their own topics for the science study, for example, biology, energy, etc. A group of students chose ecology as a focus, and the coordinator arranged for details such as bus transportation necessary for field trips to the nearby Burren,[8] where students studied plants and animals that make their home in and among the megaliths, dolmans, and limestone outcroppings of the lunar-like landscape. The students used digital cameras and scanners to digitize images for the project.

Although they generally worked in groups, students completed individual work as well. The project results and reports were posted on First Class so that students and staff at other schools could read and view them and so that students could comment on each other's work. There was even an area on the First Class space for parents to comment as well. By the time images and PowerPoint presentations were added to the First Class platform, the projects were quite large, so eventually they were burned on CDs in order to preserve the work. During a dissemination day held at the Clare Education Centre, students were able to explain and demonstrate their research.

Funding for the First Class software was made possible through the EIAT office, but yearly fees for the software are unrealistically large and impossible for the schools to fund on their own. First Class is no longer used in the secondary schools, mainly due to the cost of the software updates and the loss of the EIAT project. The SIP coordinator for this secondary school indicated that one of the most valuable aspects of the Schools Integration

Project was the opportunity to collaborate with other teachers. Although it was sometimes difficult to make time for the meetings and to get away from the daily routine, the benefits far outweighed the inconvenience. Special projects were made possible by IT coordinator teachers giving up lunches and breaks, so there was a danger that IT teachers would suffer from "burnout." The SIP teacher who supervised the First Class project had one priority for future sustainability for secondary students' ICT skills: a program where students on the second level could be mentors to younger students in primary grades.

The Special Case of the Travelers The training center for travelers[9] in Ennis is thought to be the most advanced technological education program for a traveler community in Ireland. The equipment is up to date, the software is state of the art, and the computers are networked with students' ongoing work available on the schools' own server. The success of the technology program is due in large part to an energetic and savvy information technology coordinator and an innovative center director. Together they have sought and received grants to fund their evolving technology program. In 1997 the center had two computers, but no one on the staff knew how they worked. Now the school has a current and informative Web site, where students can make contributions, and a self-paced program that is motivational for the adult students. The foundation of the educational program is the Destinations software, which offers training in basic and lifelong skills. In addition, the traveler students use Microsoft Word, Excel, Access, PowerPoint, and the Internet. Through Equalskills.com students are able to test themselves on basic computer literacy; there is also a downloadable tutorial to help students in areas where they need guidance.

Researchers heard from the staff at the center that travelers' education is often marginalized in Ireland. However, through coursework and self-education the staff has learned about technology and has been persistent in advocating for themselves, their clients, and their technology needs. In recent years the teachers and administrative staff have gained the confidence to know what they want and need in technology to use the applications for appropriate educational purposes, and this has made all the difference.

What is the impact of the adult travelers' education program on children's learning? The center has had an ongoing process to include learning units that correspond with the units that the travelers' children would be learning in their own primary and secondary schools. Since quite a few travelers leave school early, often before primary school is finished, focusing on units that might be in the primary curriculum allows parents to be able to help their children with their homework in the evenings. The travelers' center has even sponsored evening homework help programs that parents and children attend together, although these programs are not necessarily ongoing.

The Role of the Library

Children in the Ennis schools are creating their own libraries of digital materials, and teachers encourage the inquiry-based learning that makes these projects possible. However, researchers found no evidence of traditional school libraries or media centers per se in the educational environment in Ennis and, even though some schools did have a library at one time that consisted primarily of a collection of books, in most cases those rooms were taken over to become computer labs. This is an unfortunate limitation for the schools. If the schools were able to have the services of formally educated school library/media teachers, they would be able to sustain a technology education program with the librarian/media specialist serving as a technology coordinator.

On the other hand, the Clare County Library is headquartered in Ennis, and the Ennis branch library is quite advanced in its provision of materials online. A large bank of computers is available for public use, and stand-up kiosks are configured for sending and receiving email. For several years the Clare library has been developing digital libraries of materials previously held in paper form in the Clare study center, an archive adjacent to the De Valera library in the heart of the town. The archive consists of historical materials about the town and county, census papers, travel memoirs, indigenous folk tales, and a history of the Great Famine in the county, among other local history papers and records. After school hours, it is common to see younger children and older students in the library studying; however, the use of the public library does not replace the guidance and teaching that professional school library specialists could give young learners if they were part of each school's staff.

Implications for the Future

Ennis educators have learned many lessons about integrating technology into the curriculum, and children have benefited from the infusion of technology that came to the town in the years of the Information Age Town project. Through primary research, secondary research, and interviewing, children are creating Web-based learning materials. No doubt the computer literate children have a good sense of how technology tools can function to enrich and enhance learning. The future will tell, however, if the Information Age Town can sustain its successes now that the funding flow has stopped.

Issues remain for educators in Ennis. Impressive gains have been made by Ennis teachers in transforming the curricula of primary schools to take advantage of computer and networking technology; however, other innovations are still waiting in the wings. With technology available in most homes, learning does not have to be confined to the classroom or during school hours. Pupils could continue their learning through advanced independent learning modules or through activities designed to reinforce in-school

learning. More student-designed materials could be made available to the community or could be shared among schools. Secondary school teachers could work together to tap student talent in working with historical materials, doing original research, and using network and communication technologies to learn about the world around them.

One of the questions remaining for the Ennis project is how the ongoing needs of a technology environment will be maintained. Information and communication technologies need to be nurtured and sustained with updates, new software, and hardware replacements. Banks talks about the sustainability issue in her essay related to lifelong learning in networked communities: "It is essential that all user groups in a community—the local adult population, young people, education users such as schools, business, industry and community and voluntary organisations—should be catered for in the provision of Internet technology in a form which is affordable and sustainable" (1999, p. 130).

The motivation and skills are now in place among many Ennis educators. Children, too, have become comfortable and enthusiastic about "learning on the screen." If the educators wish to continue to be leaders in information age technology and learning, however, school administrators, teachers, parents, and the community will need to use all their creativity and considerable resources to provide what is needed in training, maintenance, and technology upgrades. The potential is there, and the foundations have been laid. It is for the people of Ennis to decide if they have the will to continue to be the Information Age Town, and if the schools will forge ahead with Information Age teaching and learning.

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Notes

1. The "Celtic Tiger" generally refers to the economic boom and success experienced by Irish enterprise in the late 1990s and the generally "optimistic and affluent attitude of the young" in Ireland (Trauth, 2000, p. 346).
2. Prior to the schools study, the principal investigator had also completed interviews with the Information Age Town's research coordinator and numerous local business people, economic development representatives, and a representative from the Chamber of Commerce.

3. Principals reported that the technology was piled high in their hallways when the computers and peripherals arrived, and schools had to scramble to find rooms, furniture, and enough electrical outlets to provide for functional computer labs. The influx of the equipment was so fast and so plentiful that there was little time to plan for the practicalities.
4. The Irish Department of Education and Science made funding available in 1998 "to foster whole school development in relation to ICT integration by establishing pilot projects in a number of schools, working in partnership with education centres, the community, industry, businesses, and third level institutions" (Irish Department of Education and Science, n.d.).
5. On weekends children take turns bringing the teddy bear, Mr. Seamus, home, thereby involving their families in the school program.
6. Learning Irish was made compulsory in Ireland in 1923 when the Republic of Ireland became an independent nation. Since then, the requirements of written Irish have been modified, but Irish is still required in primary schools, and, in fact, schools that teach all the subjects in Irish have become something of a status symbol for families who wish their children to leave school with a facility in two languages (Power, 2001).
7. The West Clare Railway, Meet the Musician, and Birds in the School Yard projects involved students in Ennis schools as well as schools throughout County Clare. The collaborative projects were created and implemented with the support and consultation of the Clare Education Centre.
8. The Burren is an unusual stone-paved, limestone-encrusted landscape in the northwest of County Clare bordering the Atlantic Ocean. Although it is impossible to grow crops in the Burren, it is said that the grass that grows between the stone there is particularly nutritious for cows and sheep; hence, farmers have their animals graze in the Burren in the winter months when ordinary grassy pastures may not be as lush as in other seasons.
9. The travelers are a group of native Irish who are nomadic people, changing the location of their residency periodically. During the census in 1996, it was estimated that there were 24,000 travelers in Ireland. The travelers have existed on the fringe of Irish society, and they often do not receive the services or benefits that other more traditional elements of society receive (Clans of Ireland Ltd., 2000).

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Developmentally Appropriate Digital Environments for Young Children

Linda Z. Cooper

Abstract

The developmental level of child information seekers affects their ability to interact with digital technology as a means to satisfy their information needs. Principles of child development and learning that inform developmentally appropriate practice must be considered when designing digital environments for the very young. Cognitive, physical, social, and emotional development impact a child's ability to interact successfully with a digital environment. These developmental considerations and design responses supportive of young children's information-seeking behavior, as well as perspectives of theorists in the area of child development and system design, are addressed.

Introduction

Today's child is brought up in the omnipresence of technology. A child may be exposed to digital technology even before he or she is exposed to books. Whereas the child of the recent past may have needed an introduction to computers and digital information upon beginning formal schooling, these things have very likely been a part of life for today's child from the beginning. One way that children learn is by observing their parents. Today's child may see his/her parents using computer technology more often than reading books. Digital technology has the potential to seduce young children with color, movement, sound, and interaction. It responds to a child's input in a most immediate and satisfying way. It empowers the child to make things happen instantaneously.

Given the ubiquitous nature of digital information and its significance in our culture as a means of communication, information getting,

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entertainment, and creative expression, it is important that children receive sufficient opportunities and appropriate experiences in its use. In our culture, digital technology is a tool for learning in much the same way as a pencil and paper; therefore, children need to gain facility in its use (Haugland, 1992). Knowledge and skill in this area are essential in order for children to successfully negotiate our culture. Unlike a pencil, however, digital environments have the potential to impose themselves more on a child through spoken words and moving images. Early exposure and availability of digital environments, both at home and school, make addressing design considerations for young children imperative (Liu, 1996). Computer technology, like any other tool, can be used appropriately or misused. Therefore, it is important that we use criteria when examining digital environments for children just as we would for any other learning tool or experience for children (National Association for the Education of Young Children [NAEYC], 1997).

Principles of Child Development

Domains of Development

The National Association for the Education of Young Children (NAEYC) has articulated a position statement on principles of child development and learning that inform developmentally appropriate practice (NAEYC, 1997). Child development encompasses several domains: cognitive, social, physical, and emotional. These domains are closely related in that they overlap and influence each other. While the following pages will address these different domains as they relate to digital design, it is important to remember that the domains are interwoven within the child; while we may discuss each domain as a separate entity for the sake of clarity, in reality they are interlocking facets of a whole. For example, the development of oral communication in a child involves the cognitive domain in that understanding and language learning are necessary. It involves the physical domain in that the child must gain control of mouth muscles and breathing in order to correctly pronounce words. It involves the social domain in that it requires subjective language use in order to understand and be understood in a particular culture. It involves the emotional domain in that relationships with other people are built and maintained through oral communication. Growth in each of these domains influences the other. As a child becomes more adept at oral communication, s/he is able to develop social relationships. The ability to communicate orally with other people supports cognitive development in that the child will learn from other people. Developmentally appropriate practice recognizes this intertwining of domains, and experiences are designed to support and optimize growth across domains (NAEYC, 1997).

Developmental Sequence

Development occurs in a relatively ordered sequence, and later abilities, skills, and knowledge build on previous ones (NAEYC, 1997; Piaget & Inhelder, 1969; Erickson, 1963; Bruner, 1973). Kuhlthau (1988) has commented that children's information needs relate to their developmental level. Studies show that children as young as three years old can use computers (Liu, 1996). Children younger than three years old are still in Piaget's sensory motor stage of development, during which they learn through their senses by tasting, touching, and crawling; at this stage they are not good candidates for computer use (Haugland, 2000). Children who are in preschool or primary school are most likely in Piaget's pre-operational stage of development (Piaget & Inhelder, 1969). They understand the world from their own point of view. They are individualistic, self-centered, and expect others to have their perspective. This does not bode well for the use, for example, of a highly structured digital environment even if these children could read well enough to understand the directions for use (Cooper, 1997). Piaget's concrete operational stage follows pre-operation. Children are in approximately second or third grade by this time. They use trial and error and depend on manipulation of physical items to solve problems. Their understanding of concepts such as change and comparison is physical rather than abstract. Since their understanding is still grounded in what is concrete and physical, they may have difficulty using electronic metadata even if they can read the directions and move between screens (Cooper, 2002a). A list of alphabet citations may mean much less to children at this level than an electronic display of familiar book covers. While a digital representation of book covers is not concrete, there is an observable reference to that which children have experienced concretely and understand.

Another perspective on sequential development is offered by Erickson (1963) in his stages of psychosocial development. Children in kindergarten may still be in Erickson's stage of initiative vs. guilt. They want to explore but at the same time they want to please. They are moving toward the ability to use structured systems. An early elementary child may be in Erickson's industry vs. inferiority stage and learning to master more formal competencies. Each of these stages requires emotional support and a feeling of success and increasing confidence if the child is to move toward maturity in the emotional domain. Digital environments with built-in safety nets such as spell check are supportive of emotional development as well as cognitive development. Kuhlthau's (1993) Information Search Process includes significant examination of the affective nature of information seeking. These feelings are compounded for the very young because developmentally they lack the cognitive ability, physical coordination, and social experience that older information seekers have. Likewise, Belkin's (1980) Anomalous State of Knowledge may be more keenly felt by young children since they have a significantly smaller stock of knowledge and experience on which to

base a question that will satisfactorily relate their information need. Their vocabulary is too small to express what they know they need to know.

Varying Rates of Development

While developmental stages occur in an ordered progression and new skills are dependent on old skills, the rate at which each child develops differs. In addition, an individual child can progress through different domains at different rates (NAEYC, 1997). That is, not only do different children develop at different rates, but an individual child may progress unevenly within different domains. For example, a child may have a highly developed sense of kinetics, spatial relationships, and fine motor skills. The same child may experience language difficulty. Children at the same developmental level may have different ways of knowing and learning and different ways of demonstrating what they know (Vandergrift, 1996; Gardner, 1999). Each child is unique and "variation is not only to be expected but also valued" (NAEYC, 1997). Children's skill in spelling, typing, spacing, punctuation, syntax, alphabetization, scanning, and tracking may vary (Busey & Doerr, 1993). Children in the same class at school may differ in their ability to decode, follow directions, and stay on task. In order to accommodate varying developmental rates, learning styles, and preferences of children in the same class who share hardware and software, systems should have, for example, the option of keyboarding or point and click navigation.

Learning as Building

Development moves toward greater complexity, from "behavioral knowledge" toward "symbolic or representational knowledge" (NAEYC, 1997). Learning is a building process—children need a previously existing knowledge and experiential base on which to scaffold new information if it is to have meaning to them (Bruner, 1973). For example, for very young children who may have little experience with digital environments, an interface that mimics real life through the use of graphics is supportive of a young child's developmental needs. Pejterson (1989), Borgman, Hirsh, Walter, and Gallagher (1995), and Cooper (2002b) used graphic representations of a bookshelf when working with children.

Children need to broaden and deepen the knowledge they already have, and they need the opportunity to relate this new information to something in their experience that they already understand (NAEYC, 1997). They need both the challenge of new experience and the opportunity to practice skills they already possess. Vygotsky's Zone of Proximal Development is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). A variation of this is Kuhlthau's Zone of Intervention, "that area in which a user can do with

guidance and assistance what he or she could not do alone" in the Information Search Process (Kuhlthau, 1993, p. 176). Developmentally appropriate digital environments for children support both mastery of knowledge and growth. Play is an important part of a child's social, emotional, physical, and cognitive development. It gives the child an opportunity to practice new skills and construct meaning without risk (NAEYC, 1997). Play is important because it enables children to become familiar with materials and concepts. Play becomes even more valuable when it offers feedback that the child can interpret (Bowman & Beyer, 1994).

Biology and Environment

Development and learning are affected by both biological and environmental influences. Environmental influences include those that are physical and those that are sociocultural. In terms of design and use of digital environments, at a certain developmental level a child's fine motor abilities will enable him or her to manipulate a mouse and thus move between computer screens by holding the curser over a point and moving their finger to click that point. Difficulty with this action may be due to immaturity of muscles needed in fine motor coordination or to lack of experience using a mouse because the child does not own a computer, because no one has taught him how to use one, or because his school cannot afford the hardware and software. A child may also have trouble moving between screens because she cannot read alphabetic directions or icons. Her trouble with reading may be due to a biological issue (cognitively she cannot yet relate the abstract symbols to sounds and concepts) or an environmental issue (no one has taught her to read). The particular technology that has been designed to serve as a tool toward information for a child at any developmental level needs to take multiple factors into consideration. A digitally presented story for kindergarten children may have understandable graphics, but if moving through the story necessitates a degree of fine motor coordination that is uncharacteristic for a five year old, a kindergarten child might not be able to negotiate the story. Conversely, a child may have the fine motor ability necessary to use a mouse, position a cursor over a point, and click, but if the symbols she needs to negotiate are unintelligible to her she will not progress through the story.

Vygotsky (1978) tells us that our culture not only provides us with information but teaches us how to understand that information. The link between concept and signifier—with word or icon—is arbitrary and governed by community choice. A child raised in an environment that is rich in the use of printed language and/or graphics will be more facile with these at an earlier age than a child who does not have these experiences (Cooper 2002c, 2002d). Aspects of the digital environment, such as color, size, relationship of graphics, and figure-ground relationships, may be interpreted differently

(Cooper 2002c, 2002d). Even our understanding of how knowledge is interrelated is culturally based. The Dewey Decimal System, according to which most of the public libraries in the United States are organized, is a cultural interpretation of how knowledge is interrelated (Cooper, 2004).

Research by Eleanor Rosch (1975) and Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976) on basic level category members and goodness of example impacts the design of digital environments for children. The basic level is the first category level to be named by children, the first to enter the lexicon of a language, and that level which has the most commonly used label for category members (Lakoff, 1986). For example, the word "dog" is the basic level member of the larger category of canines. "Canines" is broad, "Labrador Retriever" is narrow; "dog" is most readily understood by children. In addition, Rosch's research in goodness of example category members further supports the development of digital environments appropriate for children. Some category members are better examples than others of that category. A robin is a better example of a bird than a penguin, so the more effective graphic to represent the concept "bird" would be a picture of a robin. This depends, of course, on the environment in which the child lives. Since children in grades kindergarten through grade two are nonreaders or just beginning to read, they may rely greatly on pictures for information. Pictorial literacy is a learned skill. Children tend to be literal in interpretation of graphics. They may understand information that pictures were never intended to convey. For example, they may respond as if an element in a picture does not exist or interpret figures as incomplete (Higgins, 1980). Their understanding is literal rather than representational, and they may not have the experience necessary to make the required inference. A child needs to learn how to read a picture in such a way that he knows specifically to which information it refers, to pay more attention to some aspects and less to others. Areas for consideration when using graphics with young children include levels of interpretation, context, sequence, pictorial literacy, part-whole perception, and emphasis (Goldsmith, 1984).

The Child as Active Participant

Principles of developmentally appropriate practice view the child as an active learner and participant in his or her own development (NAEYC, 1997). Reflection deepens knowledge and understanding (NAEYC, 1997). As new experiences and knowledge become available to the child, he scaffolds the new to the old in order to deepen and broaden his knowledge base. Children use their own physical and social experiences together with the knowledge transmitted to them by their culture to construct their personal understanding of the world. They learn in order to become members of their culture (Vygotsky, 1978), and in our culture facility in digital environments has become a necessity.

Design Responses

Developmentally appropriate digital environments are designed in keeping with principles of developmentally appropriate practice as described in the sections above. The following sections address design responses supportive of development in the various domains.

Cognitive Considerations and Design Responses

Learning to read may be the greatest cognitive challenge that young children face. Young children's understandings are largely concrete and sensory rather than abstract and symbolic. As they mature, they begin to understand the symbol use of their culture. The task of reading is made up of a series of steps. Children need to recognize alphabetic symbols and attach them to sounds. They need to decode symbols groups (words) and then read each word for meaning. They need to link together series of words (sentences) and read those for meaning as well. If a child is working in a digital environment, there may be links through which he must move, and he must understand the process and progression of moving through these links to the next appropriate screen of information. Developmentally appropriate digital environments for young children support the accomplishment of these steps.

Programs that read aloud in a clear, well-paced voice help young readers attach sounds to letters, syllables, and words. Repeated reading supports language development (International Reading Association and the National Association for the Education of Young Children, 1998). Programs that enable children to manipulate speech segments, either through letters or images, allow them to build words and stories of their own while learning language (Clements, 1994). Use of icons in conjunction with or instead of alphabetic symbols support children who cannot read or read well, have trouble scanning text on a computer screen, or have trouble with the concept that an alphabetic citation stands for a book that they want. Social interaction at computers, play, and self-narration by children encourage language development (Van Scoter, Ellis, & Railsback, 2001). Programs that help children not only to count, sort, identify, and match but also to notice relationships, predict cause and effect, understand properties, draw conclusions, and solve problems support cognitive growth for young children (Davidson & Wright, 1994). Children need to learn basic relationships, sequencing, and sensory properties such as light and heavy, before and after, day and night in order to communicate effectively (Elkind, 1999). Open-ended stories that children can construct allow them to work with these concepts. Environments that allow text to be entered easily and that feature spell check and built-in prompts allow the child user to focus his or her efforts on ideas and also to model correct mechanics (Clements, 1994). Prompts can also be helpful for a child who neglects to take "the next step" in a program. For example, if a program is idle for too long, a

prompt might direct the child to take an action (Liu, 1996). Relating new concepts to those with which the child is already familiar can increase attention span and arouse interest (Liu, 1996). Such programs allow the child to scaffold new learning to an already existing knowledge base in a meaningful way. Assistance can then be gradually withdrawn (Clements & Sarama, 2003).

The sounds and images of interactive environments are intrinsically motivating to young children (Liu, 1996). Interactive programs empower children to construct their own information using sounds, images, and words. They allow children to hone decision-making skills, and they make the decision-making process more explicit for children (Char, 1990). Programs that allow children to write creatively; draw or paint; solve math problems; and manipulate shapes, patterns, and ideas are tools for thinking. Children are able to use the computer as a tool for creativity and problem solving as well as a means of reflection on the task they are performing (Bowman & Beyer, 1994).

Programs that are child controlled support different learning styles and paces (Liu, 1996). Children can repeat actions and processes and experiment with variations (NAEYC, 1996). Encouraging "children to reflect on experiences by planning beforehand and 'revisiting' afterward" helps to deepen the understanding gained from experience (NAEYC, 1997). Video or audio replay can encourage metacognition (Char, 1990; Cooper, 2002a). In addition, multiple intelligences (Gardner, 1999) are encouraged through the use of programs that support children's creative growth as well as logical and empirical thinking (Bowman & Beyer, 1994).

While passive, rote activities afford the opportunity to practice a skill, environments that support the development of higher-order thinking (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956) are desirable. Programs that pose challenging questions and encourage reasoning, predicting, imagining, and projecting support higher-order thinking (Downes, Arthur, & Beecher, 2001). Web quests can be vehicles to this end by posing problems that promote critical thinking and breaking tasks into manageable chunks that guide children through a process (Ferguson, 2001). Adult support and encouragement allow the child to move through the Zone of Proximal Development (Vygotsky, 1978) to accomplish a higher level of understanding than they would without this support. Programs should encourage children to reflect and ask questions. They should respond to children's input, offer variations that children can control, and support individual abilities and interests as well as various languages, experiences, and cultures (Downes, Arthur, & Beecher, 2001). The element of child control is particularly important because it supports the growth of facility with symbol systems. Children are thus able to connect symbols and relationships in ways that are most meaningful to them (Bowman & Beyer, 1994).

Social Considerations and Design Responses

Vygotsky (1978) tells us children learn in order to communicate with and become members of their culture. In our present culture, facility in digital environments is necessary for optimum communication. Indeed, computer communication is an important aspect of "social discourse" through which children come to understand the values and beliefs of their culture (Bowman & Beyer, 1994, p. 20). Computers have the potential to serve as "catalysts of social interaction" (Clements & Sarama, 2002, p. 1), thus supporting social development of children if used properly. Research has shown that children spend more time in conversation with peers while working on computers than they do when working with puzzles and that they show increased interest in collaborative efforts as well as an increase in helping, peer teaching, discussion, and building on other children's ideas (Clements & Sarama, 2002). Children gain knowledge about the social system through which ideas are symbolized as evidenced by the move from their own "idiosyncratic representations" to those representations employed by their community (Bowman & Beyer, 1994, p. 23). This is an important aspect of social as well as cognitive development since internalization of cultural meanings will enable children to function and participate as members of their community (Wertsch & Stone, 1985; Cooper, 2004).

The type of software used impacts the social interaction it engenders. For example, close-ended drill and practice types of software encourage turn taking. Open-ended software programs, on the other hand, encourage collaboration since the possibility of several solutions to a problem is cause for discussion (Clements & Sarama, 2002). In addition, open-ended programs support group goal setting, planning, negotiation, and resolution, as well as peer helping and teaching behaviors (Clements & Sarama, 2003) and responsible, reciprocal social relationships (Bowman & Beyer, 1994). "By asking questions and interacting with others through computer-related technology, students are able to understand more effectively than through traditional static methods such as textbooks and worksheets" (Ferguson, 2001, p. 48). Shared leadership and cooperation are enhanced (Van Scoter, Ellis, & Railsback, 2001).

"Griffin and Cole (1986) point out that the co-construction of knowledge that is possible through computer use in the international community may potentially change the framework of thought in different communities" (Bowman & Beyer, 1994, p. 23). Communication via the Internet supports both development of language skills in the cognitive domain and interrelationship skills in the social domain (Subrahmanyam, Kraut, Greenfield, & Gross, 2000; Bowman & Beyer, 1994). Supportive environments need to recognize differences in the experiential and cultural backgrounds of child users. Young children are most likely to understand information at the basic level (Rosch et al., 1976), and so examples used in digital environments

should be appropriate to the audience. Depending on their background, young children may not have experience in focusing attention on the most important aspect of a visual display (Cooper, 2002c). A supportive design element may, therefore, draw attention to important areas via judicious use of color, sound, or movement. Images should be understandable to children. Consideration should be given to whether the child user is accustomed to "reading" information from left to right, right to left, or up and down. Care should be taken with the use of color having cultural connotations (Cooper 2002c; Pettersson, 1982).

Digital environments supportive of development in the social domain do not present stereotypes of people; rather they present diversity in culture, language, ethnicity, age, ability, and lifestyle (NAEYC, 1997). They present positive social values and are nonviolent. For example, mistakes are not "blown up," but rather the child may be offered several ways to correct the mistake that are socially acceptable and realistic (NAEYC, 1997).

Situations that support the social development of children not only maximize social interaction and cooperation but afford equal access for all children (Appel & O'Gara, 2001). So, for example, permission to use open-ended programs supportive of higher-order thinking skills and social growth should not be awarded for good behavior or high academic achievement while low-achieving students are directed to drill and practice programs (NAEYC, 1997). Children vary in their developmental levels regarding cooperative behaviors, following directions, and ability to stay on task. Programs that encourage contributions from multiple members of a group to solve a problem allow children to have directions repeated/demonstrated either orally or visually and offer immediate feedback, positive reinforcement, and support for growth in these areas.

The physical environment in which children pursue the digital environment impacts the degree to which social development is supported. Ideally, there should be at least two seats in front of the computer screen. There should also be a seat to the side for a teacher or other supporting adult. When computers are placed close to each other, children are encouraged to share ideas. When computers are centrally located rather than isolated, other children are easily invited to participate and a teacher/adult can oversee without looming (Clements & Sarama, 2002). Clements, Natasi, and Swaminathan (1993), as reported by Bowman and Beyer (1994), suggest a sample activity in which children construct digitally generated drawings as a group. They discuss the relative size of the object produced by inserting various numbers into the program, and they visually connect the relationship between a number and an object size. They control the relationship themselves and thus learn about estimating. They also learn important social skills regarding cooperation to create a product and reach a goal (Bowman & Beyer, 1994).

Physical Considerations and Design Responses

Computer hardware and software afford multiple accommodations that support children who are not yet at a developmental level at which they can negotiate physical environments designed for adults. Children who are nonreaders, beginning readers, or emergent readers may not be able to track and scan text with ease. An overloaded screen may make it more difficult for a young child to focus on a particular area. The use of a larger font and readable font style as well as inclusion of less text and/or images on a page make it easier for children to address the information on the screen. Information should appear in both text and icon format (Liu, 1996). Use of color to help young children distinguish objects from each other on a screen, and uncomplicated shapes that are recognizable, also support the child viewer. Material on the screen should be presented in a clear and consistent manner throughout a program. Icons, text, buttons, and a Help area that appears in the same place on every screen make it easier for children to progress through a program (Liu, 1996).

Typing is a concrete activity that produces immediate results via both the confirming "click" of the keys and the visual symbol produced. Children need less fine motor coordination in typing than is necessary for writing and have the satisfaction of immediate gratification in seeing the results of their efforts (Clements & Sarama, 2002). Large keyboards make it easier for children to type without error (Liu, 1996). While some children are developmentally able to manipulate a mouse and move a cursor over a point and click, other children may not yet be ready to do this. Touch screens make it easier for children at different ability levels to interact with a digital environment. It is also more intuitive to touch a screen than to type a response or command (Liu, 1996). Accommodation of physical developmental needs for special needs children enables them to participate in group activities that equalize the "playing field" so that they can interact with their age peers (Clements & Sarama, 2002; Clements, 1999).

Emotional Considerations and Design Responses

"Children develop and learn best in the context of a community where they are safe and valued, their physical needs are met, and they feel psychologically secure" (NAEYC, 1997). Emotional development as it relates to Erickson's (1963) psychomotor levels of development, Kuhlthau's (1993) Information Search Process, and Belkin's (1980) Anomalous State of Knowledge have been addressed earlier in this article. In addition, Maslow (1998) offers a perspective on human needs in his hierarchy of needs relating to physiology, safety, love, esteem, and self-actualization. Children need a secure environment in which they can explore and develop without confusion, doubt, and fear of error (NAEYC, 1997). Environments that are supportive are those that offer the ability to avoid or correct errors, go back, review, hear or view again, and provide feedback so the child knows what is

happening. For example, a blinking cursor will help a child to understand that a component is loading rather than thinking that she has made an error (Liu, 1996).

Research by Astleitner and Leutner (2000) in the area of emotions and affective considerations in children using digital environments suggests that fear, envy, anger, sympathy, and pleasure all influence a child's success in using technology. Their studies indicate that fear of failure can be assuaged by support measures that help ensure success, such as feedback, overviews, advance organizers, and self-checking mechanisms, as well as pace of instruction and reduction of task difficulty. In addition, offering methods to correct mistakes and giving the child the ability to turn mistakes into learning experiences also support the child emotionally. For example, they suggest that mistakes might be turned into a question-and-answer list to which students contribute, thereby helping others. Fear of failure may be lessened by giving children tools to organize information so that it is less overwhelming. These might include methods of putting information into hierarchies, databases, or spreadsheets. Students may also be encouraged to find patterns, rank ideas, develop timelines, categorize, and compare.

Astleitner and Leutner (2000) further suggest that envy may best be assuaged by limiting competition and comparison of children and/or their work. Care should be taken that anger does not spread or accumulate. Programs should be designed that allow anger to be expressed in a constructive manner that corrects unfair situations, monitors events, and leads to resolution. For example, use of an "anger button" that, when pressed, leads to a Help area may help students toward anger resolution. Students can be encouraged to be more flexible by offering links to other points of view concerning the same information (Astleitner & Leutner, 2000).

PETS, A Personal Electronic Teller of Stories (Druin et al., 1999), is a collaborative project in which adults and children work together to design a storytelling environment that uses robots controlled by elementary school children. Child designers identified six emotions that were incorporated into the design: happy, sad, lonely, loving, scared, and angry. Children can construct a robotic pet by connecting animal parts (for example, head, paws, etc.) and then use the animal to tell stories using My PETS software. The software enables them to incorporate emotions into their story by having the robot perform specific body movements. For example, if the robot is sad its body will droop. Children are always in control, and self-expression conveyed through the animal robot enables them to discuss "difficult emotional issues" (Montemayor, Druin, & Hendler, 1999).

Astleitner and Leutner (2000) note that some emotions are considered socially positive. To encourage sympathy, relationships can be intensified by making communication between children easier through email, listservs, or chat sessions. Cooperative learning structures such as groupware, integrated classroom management tools, application sharing, and low-level author-

ing tools through which contributions can be extended by other students also support relationship building. Enhanced well-being can be supported by activities that increase skills or are intrinsically satisfying. User-friendly environments support speedy connection and loading of pages, offer cues for users, and have clear selection areas, progress tracking, help areas, and short pages (Astleitner & Leutner, 2000). Student-controlled learning, use of humor, and play activities also support pleasurable experiences in digital environments. Student-directed learning also supports the development of autonomy in learning rather than always seeking authority (Clements, 1994). This, in turn, supports children as lifelong learners (American Association of School Librarians & Association for Educational Communications and Technology, 1998).

Summary and Closing Thoughts

As we have seen, experts in the area of child development (Appel & O'Gara, 2001; NAEYC, 1996; Davidson & Wright, 1994; Haugland, 2000; Downes, Arthur, & Beecher, 2001; Clements & Samara, 2003; Van Scoter, Ellis, & Railsback, 2001; Ferguson, 2001) suggest that developmentally appropriate digital environments should

- support the child as a unique individual;
- be child controlled;
- be open-ended rather than close-ended;
- be active rather than passive;
- involve many senses;
- encourage exploration, experimentation, and risk taking;
- encourage critical thinking, decision making, and problem solving;
- offer quick feedback, be interruptible, and keep records;
- balance familiarity with novelty;
- be user friendly;
- be progressively leveled, offering new challenges;
- be responsive to child input;
- build on previous learning;
- encourage reflection and metacognition;
- support social interaction.

Overall, these criteria are similar, if not the same, to those used for any developmentally appropriate material designed for young children. An often argued question is whether computer use contributes to or damages the education of young children. If, as noted above, developmentally appropriate digital environments can be evaluated by criteria similar to those of any other developmentally appropriate material for children, then the answer to this question is that "it depends." It depends on the material used, the circumstances of its use, and the way it is used. Most of all it depends on the readiness of the individual child for a particular environment. Even

the most excellent nondigital material is not appropriate for all children. In this same way, even the most excellent digital material will not be appropriate for all children. Technology is a tool, not a solution. It is not "the answer," nor is it a panacea any more than a power tool is when we have trouble doing a job with a hand tool. One might even say that in the case of both computer technology and power tools, we can accomplish more and possibly better things, but there is also a potential for bigger mistakes. Technology is clearly not a substitute for human interaction and attention to the unique needs of each child, nor should it be the scapegoat when these things are not provided. However, attention to design that is developmentally appropriate and supportive of children's needs as exemplified by recent adult/child design collaborations (Druin, 2002; Bilal, 2003; Large, Beheshti, Nesset, & Bowler, 2003) moves us closer to a wiser, more enlightened implementation of technology as a tool for children's learning. The concept of children as design partners demonstrates a respect for their intelligence and creativity as well as increases the likelihood of usability and high interest level for children. Digital environments are tools that broaden and extend learning possibilities for children. An appropriate digital environment provides a vehicle that can take a child further than he or she might travel unassisted. Responsible and well-considered design and content choices in keeping with a child's developmental needs provide the basis of positive digital environments for children.

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Creating Metadata for Children's Resources: Issues, Research, and Current Developments

June Abbas

Abstract

A key challenge to retrieval in any type of system is how to represent the resources appropriately so that the user(s) can find what they are looking for. In systems being used by children, as well as those designed specifically for children, there exist two fundamental representation problems: (1) the metadata or representation scheme of the system may not be designed with this specific user group in mind, and (2) few age-appropriate controlled vocabularies exist for use in creating metadata. Existing research in these two problem areas and the impact on the users' information seeking and retrieval experiences are presented. Current projects and developments, and the contribution that the users themselves can provide, will give the reader further insight into the issues and potential opportunities for research and application.

Introduction

Children[1] have unique information needs and information-seeking strategies (Walter, 1994). In today's increasingly digital world, children have access to a wide variety of resources in many different formats. They access information by using a variety of information retrieval systems such as library online public access catalogs (OPACs), online database systems, and the Internet and/or the World Wide Web (WWW). Within the Web environment, children can now access specialized collections of resources in digital libraries, subject directories, and Web portals that are designed specifically for their use. Increasingly, children prefer digital resources to locate information for school, to surf for entertainment, and to locate personal information (Levin & Arafeh, 2002; D'Elia, Abbas, Bishop, & Rodger, 2004).

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In order to maximize the success of children's information seeking and use of the information systems, the resources[2] contained within the system should be represented at a level that is appropriate for this particular group of users. The metadata scheme and the metadata[3] describing the system resources should reflect an understanding of how children access, organize, and use information, but it must also take into account the user's understanding of how the system works and how the resources are represented within the system. This article describes the complexity of the representation process and research and developments in metadata schemes and age-appropriate controlled vocabularies. Current projects and the contributions that the users themselves can provide are discussed. Insight into the issues and potential opportunities for research and application will conclude the article.

Representation

Information systems provide various means of accessing the resources of a collection. Users most often, with the exception of Web pages, are searching digital representations or surrogates of the resources and not the resources themselves. These representations can be in the form of bibliographic records in library OPACs, inverted indexes in online databases and digital libraries, or indexing codes embedded into the objects themselves. Each system's database structure or metadata scheme may vary, but the fundamental operation of the scheme or the metadata therein is to represent or describe the objects in the collection to facilitate retrieval.

Representation, or creating metadata, is not as simple as writing descriptions and/or choosing subject terms. It is a complex sociocognitive process in which many variables come into play. It has been defined using many lenses, such as library and information science, cognitive science, and linguistics, among others. O'Connor defines representation as "the set of means by which one thing stands for another. . . . [It is] a complex web of attributes of disparate objects and concepts, idiosyncratic and socially constructed codes and agreements, and neurological abilities" (1996, p. 11). Blair (1990) sees the problem of representation and information retrieval as linguistic in nature. How effectively we utilize language to represent an object determines the success or failure of the information-retrieval process. Blair also posits that the language that we use to express our information needs, as well as document representations, is learned in a social context or community. Using Wittgenstein's theory of "language games," Blair explains that we do not acquire language purely by learning the word and its definition but instead by learning its use and appropriateness within the context of our "forms of life" or everyday experiences. Furthermore, we have to possess some prior understanding of the form of life or the language game context we are engaged in before the words can have meaning.

An important aspect of learning in general is the acquisition and application of the terminology of the subject. Children engage in "language games" as they go through their daily "forms of life" or experiences. Direct influences on their learning are their parents, teachers, the documents they engage with (textbooks, Web resources, etc.), and the information systems they interact with. Learning and knowing the appropriate "language" or terminology to use within these contexts is vital to their success both in information retrieval and content understanding.

O'Connor (1996) also notes that the user's developmental and cognitive state and domain and system knowledge, and the indexer's knowledge of the user and his/her intended purpose(s) for the objects, can affect representation and retrieval. His assertion is supported by the research community's exploration of obstacles or problems children encounter during information retrieval, such as term selection, developing and expanding search terms, and use of truncation and stemming (Abbas, 2001; Bilal, 2000a, 2000b; Cooper, 2002; Solomon, 1993). Studies of children's book indexing further illustrate the importance of understanding children's cognitive and developmental levels. Choosing age-appropriate terms and consistent use of word tense, as well as other issues concerned with order, display, and formatting, are crucial to providing appropriate metadata within indexes (Bakewell & Williams, 2000; Miller, 1973, 1980).

When creating representations for children, the process is further complicated by: (1) our incomplete picture of this group of users, (2) metadata schemes designed for use by adults and not children, (3) the lack of age-appropriate controlled vocabularies and guidelines used to create metadata, and (4) the differing cognitive abilities, developmental levels, and system knowledge of children.

Research and Applications

While there exists a significant body of research into adults' use of information systems, information-seeking activities, and understanding of the system's representation schemes, little research has focused on children. Use of OPACs (Borgman, Hirsch, Walter, & Gallagher, 1995; Solomon, 1993), CD-ROM and other electronic resources (Large, Beheshti, & Rahman, 2002; Large, Beheshti, Nesset, & Bowler, 2003), and the Internet and/or WWW (Bilal, 2000a, 2000b) or digital libraries (Abbas, 2001; Druin, 2002, in press; Druin et al., 2003) by children has been investigated.[4] While information-seeking research is beyond the scope of this article, it still remains a critical piece of the representation puzzle and serves to inform researchers, metadata creators, and system developers of the unique needs of children. Currently there exists a considerable gap in our understanding about (1) representation issues in information seeking, (2) metadata schemes designed to describe children's resources, (3) the development

and use of age-appropriate controlled vocabularies, (4) the impact that using an age-appropriate metadata scheme and controlled vocabulary can have on children's information seeking and access, and (5) the advantages and disadvantages of involving children in metadata scheme and/or metadata creation. Research in each of these neglected areas is presented in the next section.

Representation Issues in Information Seeking

Many factors impact information retrieval. Representation of resources or creation of metadata is a key factor. Retrieval requires an intersection of metadata used within the system and the user's search terms. Information-seeking research has uncovered representation obstacles such as spelling errors, misuse of search features, difficulty in selection of initial and alternate search terms, and the inappropriate nature of the system's controlled vocabulary (Moore & St. George, 1991; Solomon, 1993; Borgman, Hirsch, Walter, & Gallagher, 1995; Hirsh, 1997; Bilal, 2000a, 2000b; Shenton & Dixon, 2003; Abbas, 2001). Other research links children's cognitive and developmental abilities to issues of retrieval as well as system design (Cooper, 2002; Bilal, 2000a, 2000b; Borgman, Hirsch, Walter, & Gallagher, 1995; Hirsh, 1997).

Children's understanding of how a system works (not just searching), in addition to what is being searched—the metadata scheme and metadata—as well as the rules for creating metadata, is also important but has received little attention by researchers. Children are required to understand and use a variety of systems, each of which (on the surface) contain different search mechanisms, interface designs, and metadata. These differences can be confusing to users. Behind the surface, systems use different metadata schemes and controlled vocabularies. Jacobson notes: "there is no metaphor or analogy within a child's experience that enables a useful link to this form of knowledge representation. . . . [Furthermore] this is not to say that an appropriate (or matching) mental model will always make children more proficient searchers, but it will give them a better chance of understanding the tool they use for searching and why searches might come out the way they do." (1995, p. 68).

Studies of adults' understanding of controlled vocabularies such as Library of Congress Subject Headings (LCSH) indicate that even they do not understand how controlled vocabularies are used in systems and that they, the users, can actually use these lists of terms in searching (Drabenstott, Simcox, & Fenton, 1999). Theimer (2002) also indicates a lack of congruence may occur between a user's meaning for the search term and the meaning or definition of the term by the controlled vocabulary's creators.

These studies indicate that the obstacles encountered by children during information retrieval may result because of representation issues such as inappropriate controlled vocabulary used to create metadata, or metadata

schemes that might not include elements children expect or need to find when searching. The research further suggests that systems designed for use by children should use both a metadata scheme and a controlled vocabulary that has been specifically designed with younger users' cognitive and developmental needs in mind.

Metadata Schemes Development

Few research studies of metadata scheme development or augmented metadata schemes for use in children's systems have been reported in the literature. This remains a largely neglected but vital area of research. Examples that we might learn from include (1) OPACs designed specifically for children, (2) commercial database vendors' renewed efforts to provide "kid-friendly" systems, and (3) developments within the digital libraries community to design user-centered digital libraries for children.

Systems Designed for Children and Young Adults Beginning in the 1990s researchers began studying children's OPAC and database use. Their findings led to many developments in systems and interface design based on an awareness of how children search, which features they like to use, and their obstacles to retrieval. Borgman, Hirsch, Walter, and Gallagher (1995) developed a keyboard-independent system that enabled children to browse subject content of a science collection. The focus of their studies examined children's engagement with the system and the effectiveness of the iterative design of three different interfaces. They did, however, make use of a standard controlled vocabulary (LCSH) to represent the documents within the collection.

Two examples of OPAC interfaces that augment an existing library catalog's metadata scheme in order to make representations more appropriate for children are the Bücherschatz and Book House interfaces. Bücherschatz, a prototype hyperlink catalog for children developed in Germany, uses descriptions written specifically for children. The descriptions are designed to peak the children's interest and to be whimsical, fun, and thrilling. This catalog uses three primary access points into the collection for the children: books for fun and leisure; books on children's life and problems; and other nonfiction books. Each of these three access points is represented by a picture: an octopus, a seagull, and a pirate. The catalog uses a treasure hunt theme as the metaphor of children searching for information or "treasure," hence the graphics used for the main access points (Kulper, Schultz, & Will, 1997).

Pejtersen developed Book House, a Danish interface for children's materials. This interface is icon based and includes very in-depth metadata. The bibliographic records include additional information such as level of reading difficulty, time period, geographic location, and the emotional effect the book may produce. At the time Book House was developed these elements were not traditionally found in bibliographic records, nor are they

all present today. Lundgren and Dalgaard further augmented the system with an online form that allowed the children to write book descriptions themselves. The book descriptions were primarily written by eleven and twelve year olds and contained very emotive descriptions of the books as well as evaluative comments of the books (Lundgren, 1998).

Commercial OPAC vendors have also been implementing child-centered interfaces to their OPACs. For example, the Kids Catalog, developed by Sandlian, Busey, and Doerr in 1990 (Sandlian, 1995); Kids Online, developed by the vendor Innovative Interfaces; DRA Kids, developed by Data Research Associates; Book House, developed by Pejtersen and later tested and augmented by Lundgren and Dalgaard (as mentioned above); as well as other Web-based interfaces such as Follett Software Company, Book Systems, Inc., Inspire Kids, and Just for Kids have taken into account researchers' findings on children's information-seeking activities in their design.

Commercial Databases Recently, emphasis on the development of age-appropriate interfaces for commercially available online databases (Gale Group's Kids InfoBits, EBSCOHost's Searchasaurus, and others) can be noted; however, more research into their use and impact needs to be conducted. While much of their efforts appear to be focused on interface design and searching functionality, they have begun to use content-specific metadata schemes and subject-specific controlled vocabularies.[5]

Web Developments A wide variety of metadata schemes are being developed as more subject directories, Web portals, and digital libraries appear online. Web metadata creators use either generic metadata schemes such as the Dublin Core (DC) to represent resources, or they adapt existing metadata schemes such as Machine Readable Cataloging (MARC) and DC by adding additional elements (or database fields) that are subject or audience specific. Additionally, specialized metadata schemes are being designed with a particular group of user(s), resources, and uses in mind. The research literature and case studies of metadata scheme creation focus on the development, use, and adaptation of metadata schemes. Other emphasis is concerned with system architecture and interoperability issues.

Subject directories and Web portals for children have either developed simplified metadata schemes or have augmented interface features to allow for subject-based category browsing or hierarchical browsing. KidsClick, designed by a group of librarians at the Ramapo Catskill Library System in New York, uses a simplified metadata scheme including only five elements: Web address, title of site, brief description (abstract), reading level, and subject headings. The KidsClick metadata scheme has been adopted by the Colorado Virtual Library for Kids with an additional metadata element added for content standards to make it useful for teachers who access the collection (Bailey-Hainer, 2001).

Digital Library Developments Digital libraries have mainly adult users (educators, business communities, general users of varying ages) as the focus with very few digital libraries being designed specifically for use by children. It is difficult to find documentation on each of the different systems' metadata schemes and controlled vocabularies. Visiting their Web sites unveils little in terms of system design. Few case studies have yet been published with metadata scheme development or controlled vocabularies as their focus.[6] A further issue is the lack of coordinated effort between the communities (El-Sheribini & Klim, 2004). A few researchers in the digital library community have designed systems and interfaces for children's use and have been exploring more innovative approaches to metadata scheme development and metadata creation. These are described briefly below.

International Children's Digital Library (ICDL) Druin (1999, 2002, in press), Druin et al. (2003), and Reuter and Druin (2004) have been working with young children as design partners to create the International Children's Digital Library. The research team worked with children to design the interface, specialized search features, metadata scheme, and categories for classification, access, and organization of the resources. The ICDL collection contains almost 600 digitized children's books in at least 30 different languages. Children are able to access the resources by several innovative means: (1) clicking on the geographic location or continent on a spinning globe, (2) browsing with three different interactive screens, and (3) searching with traditional and nontraditional access points (such as name and author, but also emotive response, shape, and color).

ICDL user studies relevant to this article indicate that children preferred searching using nontraditional metadata elements (search categories) such as age level, language, genre, color, or "how books made children feel." These findings suggest that we need to rethink metadata schemes in systems designed for children. Children *did not* prefer the same elements in metadata schemes as those traditionally used by adult users.

National Science Digital Library (NSDL) Members of the NSDL community have been developing a wide variety of digital library collections for use by K–16 users and educators. This digital library community is exploring issues of (1) system architecture, (2) metadata scheme development, (3) interoperability of metadata schemes, (4) harvesting (sharing) of metadata, (5) content creation rules/guidelines, and (6) controlled vocabularies for elements in the metadata scheme. The current and previous NSDL funded projects note other promising projects relevant to metadata scheme and metadata creation. For example, Alice Agonino's "Developing a Learner-Centered Metathesaurus for Science, Mathematics, Engineering, and Technology Education" (NSF DUE grant #121743) project is developing a user-centered metathesaurus by examining user queries; and Marcia Zeng's "Quality Analysis of the Metadata Records in the NSDL Metadata

Repository" (NSF DUE grant #333572) will develop standards for quality assessment of the metadata developed for NSDL records.

While there is a wide variety of metadata schemes available, content creation guidelines/rules are not as prevalent in the Web environment (Sutton, 2004), which can make representations inconsistent and present many problems to metadata creators who wish to share metadata or who are concerned with interoperability between their system and other online systems. Digital library communities such as Dublin Core, the Gateway to Educational Materials (GEM), and the NSDL have ongoing efforts to develop content creation guidelines for their members to use when creating metadata.

Controlled Vocabulary Development

Metadata for digital resources is obtained using three primary methods:

1. Catalogers/metadata creators or individuals not involved in the creation of the resource; these creators may or may not be librarians or subject specialists
2. Authors or creators of the resources
3. Software tools used to harvest the metadata, such as the Open Archives Initiative (OAI) Harvester used by digital libraries such as the NSDL

Libraries have been creating representations or catalog records for children's resources for many years. Catalogers create representations using the MARC database scheme and guidelines or rules for content creation present in the Anglo American Cataloging Rules (AACR2) and/or Library of Congress Subject Manual. Other resources used include controlled vocabularies and classification schemes such as the Library of Congress Subject Headings (LCSH), Sears List of Subject Headings (Sears), subject-specific thesauri, and the Library of Congress Classification (LCC) or Dewey Decimal Classification (DDC) schemes.

Controlled vocabulary use in Web and commercial systems also varies. It is often difficult to determine which vocabulary a system is using because of the scant documentation on the system's Web sites and/or the lack of literature containing this information. It is also difficult for collaborative efforts such as the NSDL and GEM to require their members to use any one specific controlled vocabulary. In several digital libraries LCSH and/or specially designed thesauri, ontologies, and classification schemes are being developed and used, but these controlled vocabularies are designed to meet the information-seeking needs of adult users, not children.

Development of controlled vocabularies has focused on the user as either a homogenous group with no age specified or on a specific discipline or domain. Few efforts to develop controlled vocabularies for children exist. The following section will outline efforts to develop age-appropriate controlled vocabularies, as well as detail the current systems that are being designed to involve users in the metadata creation process.

Past and Present Efforts Perhaps the most significant effort to develop or adapt an existing vocabulary for children's metadata creation is the Library of Congress' (LC) Annotated Card (AC) program. In 1966 the Library of Congress established the AC program, which is currently administered by the Children's Literature Team of the Library of Congress History and Literature Cataloging Division. The program has adapted the LC's cataloging guidelines and practices and has modified the LCSH as well as the guidelines for their application to be more appropriate for the representation of resources for children up to the age of fifteen years. The AC guidelines address issues of creating age-appropriate metadata in the description, name, subject, and classification elements in the MARC metadata scheme (Association for Library Collections and Technical Services [ALCTS], 1998).[7]

Another controlled vocabulary, predecessor to the Annotated Card list, is the Sears List of Subject Headings (Sears). It was designed for use by small libraries by Minnie Earl Sears in 1923. Sears differs from LCSH and AC in many ways that make it appropriate for representing children's resources. For example, it contains fewer technical terms, prefers common names instead of scientific names, uses direct geographic subdivisions, and has converted inverted headings into direct forms (Miller, 1998).

A further effort by members of the Online Computer Library Center's (OCLC) Knowledge Organization research team has produced "Subject Headings for Children," a list of approximately 20,000 LCSH subject terms. The list was compiled by searching OCLC's WorldCat database of bibliographic records. The list includes LCSH terms and some specially devised terms. Name headings from LC's Name Authority File are also included. Reviews indicate that the list is probably useful but still contains many inappropriate terms, such as "miscellanea," and it does not incorporate terms in common use by children (Towsey, 1999).

Other smaller-scale efforts include Jansson's development of a special thesaurus for children consisting of about 800 simple, concrete words within 21 areas of interest. Librarians using the list to represent documents are encouraged to add to the list as they feel necessary. This list has been distributed to libraries in Sweden, where it has been met with much approval (Lundgren, 1998).

Users as Contributors Even less attention has focused on the potential of involving the children who use the system in the creation of metadata. Abbas (2001, in press-a) has been exploring the use of children's search terms as a source for controlled vocabulary. She has created a list of student-generated keywords (SGKs) by comparing users' most frequently used search terms to those of the controlled vocabulary used by the ARTEMIS Digital Library, a digital library of science and technology resources for fifth through twelfth grade students. (The controlled vocabulary used by ARTEMIS is UMI's Proquest Controlled Vocabulary, not specifically designed for use in

children's resources.) Frequently-used search terms were mapped for direct, synonymous, related, complete, and partial phrase match. Terms that did not match the system's controlled vocabulary were then compiled into a list of student-generated keywords. Studies of using automated means to map user's search terms to terms used within the system's controlled vocabulary have been explored but mainly in the medical or business domains and *not* for systems used by children (Greenberg, 2001).

Efficacy Studies The efforts detailed above show promise. However, little effort has focused on determining if existing and developing sources of metadata meet the needs of children. Studies examining the impact the use of age-appropriate metadata schemes and/or controlled vocabularies can have on children's information seeking and access are difficult to find. Abbas (2001) used a list of SGKs, as detailed above, to augment existing metadata in the ARTEMIS Digital Library. She then re-executed a subset of the students' original queries and compared the two result sets. Thirty-two percent of the search results showed an increase in the number of relevant documents retrieved that contained SGKs.

Other studies we can learn from are the extent of match studies conducted by Taylor (1984), Markey (1984), Carlyle (1989), Doyen and Wheeler (1989), Lester, (1989), and Drabenstott and Vizine-Goetz (1990), in which users' search terms are compared to those of the controlled vocabularies used by the system. At least one study has tried to ascertain users' understanding of metadata descriptions. Drabenstott, Simcox, and Fenton (1999) studied end-user understanding of subject headings in library catalogs. Their study did include children and findings indicated the following: (1) there were differences between adults' and children's understanding of subject headings, and (2) children understood the meanings correctly only 31 percent of the time, while adults had the correct meanings only 39 percent of the time. Jacobson (1995) notes that the most prevalent controlled vocabulary in use in library systems, the LCSH, contains "arcane words that are at most above the sixth grade level," thereby making their use inappropriate for younger users.

These studies all illustrate to varying degrees *adults'* understanding of subject headings and their use in library OPACs, with little information on *children's* understanding of the metadata or the controlled vocabularies used. More research should be conducted into users' understanding of the controlled vocabularies being used by our systems, as well as the efficacy of the development and use of age-appropriate metadata schemes and controlled vocabularies.

Challenges and Opportunities

Challenges

As illustrated throughout this article, there are many gaps in the research on metadata creation and the development of age-appropriate metadata schemes for children's digital resources. While designers of systems and the digital library community are working through many of the issues of building user-centered systems for adults, more attention needs to be paid to younger users and their unique needs.

Information seeking and usability studies *are* beginning to help paint a more complete picture of children's information seeking activities and the obstacles they encounter. From prior studies with children we know that (1) children have difficulty using systems designed for adults and encounter many obstacles such as spelling errors, misuse of search features, and difficulty selecting search terms; (2) children's cognitive abilities and levels of development have an effect on their information seeking and retrieval success; (3) systems designed for children may not include age-appropriate metadata schemes and metadata; and (4) children prefer using nontraditional search elements such as color, genre, age level, or emotional response.

What we do not know much about is (1) children's understanding of or mental models of systems or how they work; (2) how this lack of understanding affects their information seeking; (3) if the new child-centered systems have had a positive effect on their information retrieval, and (4) how the use of age-appropriate metadata schemes and metadata will alleviate some of the information retrieval obstacles children encounter. These gaps represent rich research areas that need to be explored further.

Opportunities

The few studies conducted to date (Abbas 2001; Reuter & Druin, 2004) indicate that children can benefit from metadata schemes and metadata developed with their unique needs in mind. However, to date few efforts to develop age-appropriate controlled vocabularies for metadata creation have been reported. The author realizes that development of controlled vocabularies is a very lengthy process with many variables that must be considered and communities that should be involved. There exist, however, many as yet untapped potential sources of terms, including the following: (1) users' search strings that are gathered as part of OPAC, database, and digital library systems' operations; (2) textbooks and other resources used in classrooms that have been designed by education experts (thesauri, dictionaries, encyclopedias, etc.); and (3) Web resources created specifically for children. Another resource that holds promise is word frequency lists that are compiled by researchers in education and reading studies. These lists include terms that appear frequently in the literature (fiction and nonfiction) being read by particular age groups (Stuart, Dixon, Masterson, &

Gray, 2003). These sources could be a rich resource containing terms that children are currently learning in their "language communities."

Automated mapping from search terms to metadata is being explored for use in the business and medical communities. Why not for children's systems as well? If this proves to be a viable solution to resources for adults, it should also be explored as an option for younger users.

These are but a few suggested possibilities worth exploring. However, what might yield the *best* possible results is to continue working with the children themselves. Involving children in metadata creation will give us more insight into this user group's unique representation needs. Involving them in the *entire* system design process will teach us more about them, their information needs and system use, and the obstacles information professionals and researchers still need to address.

Notes

1. For the ease of the reader, the term "children" will be used to indicate both children (ages 0–11) and young adults (ages 12–18).
2. The term "resources" refers to any of the multiple formats of digital objects that might be found in an online system, for example, textual Web pages, images, multimedia, sound files, etc. This article is not concerned with specific issues of representing different formats.
3. There are many definitions in use for the term "metadata." The most popular is simply "data about data." Due to the complex nature of representation or metadata creation, our definition is expanded to include the structured nature of the end product and the variety of differing schemes and content rules in use to create metadata. For a more detailed coverage of metadata and its many facets, as well as the many efforts and schemes being developed, refer to Hunter (2003) and El-Sherbini and Klim (2004).
4. These are but a few citations to this valuable research. For more comprehensive coverage, see Abbas (2003, in press-b) and Large (2005).
5. Further information on commercial online database vendors can be found at their Web sites: Gale (http://www.galegroup.com/schools), EBSCOHost (http://www.epnet.com/school/esmenu.asp), and Proquest (http://www.proquest.com/). Reviewing commercial databases' online documentation revealed little information about the controlled vocabularies or the metadata schemes being used by the systems. Online databases developed specifically for use by children, such as Gale Group's Kids Infobits, mention briefly that users' searches are reviewed, but no explanation of how this research was applied is available in online documentation.
6. Two examples of developing metadata schemes for specific users and collections are Metadata Objects Description Schema (MODS) and Learning Object Metadata (LOM). MODS is being developed by the Library of Congress' Network Development and MARC Standards Office, as well as other metadata experts. It can be used for a variety of purposes, particularly for library applications. As an XML schema it is intended to be interoperable with existing MARC 21 records, as well as be used to create new metadata. To learn more, visit the project site at http://www.loc.gov/standards/mods/. LOM, under development by the Institute of Electrical and Electronics Engineers (IEEE), is intended for use with collections of learning objects. To learn more about the scheme and the project visit http://ltse.ieee.org/wg/21. Case studies outlining issues involved in the development of metadata schemes, interoperability, collaboration, and technical infrastructure of digital libraries currently being designed for adults are presented in *Metadata in Practice* (Hillman & Westbrooks, 2004).
7. For an in-depth history of the Library of Congress Annotated Card Program and application of the guidelines and use of the AC list of subjects, please refer to Zuiderveld (1998). Of particular interest are chapters 1 and 2 by ALCTS and Janet E. Gilchrist respectively.

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Interface Design, Web Portals, and Children

Andrew Large and Jamshid Beheshti

Abstract

Children seek information in order to complete school projects on a wide variety of topics, as well as to support their various leisure activities. Such information can be found in print documents, but increasingly young people are turning to the Web to meet their information needs. In order to exploit this resource, however, children must be able to search or browse digital information through the intermediation of an interface. In particular, they must use Web-based portals that in most cases have been designed for adult users. Guidelines for interface design are not hard to find, but typically they also postulate adult rather than juvenile users. The authors discuss their own research work that has focused upon what young people themselves have to say about the design of portal interfaces. They conclude that specific interface design guidelines are required for young users rather than simply relying upon general design guidelines, and that in order to formulate such guidelines it is necessary to actively include the young people themselves in this process.

Introduction

Children do not think in the same ways as adults (Bjorklund, 2000; Siegler, 1996). This has been recognized, for example, by the publishers of specialized reference books for children and in the separation of the children's library from the adult's library. Children now are using the Web widely as an information source for both learning and leisure, yet overwhelmingly they are using not specialized portals designed for children but rather adults' search engines or portals such as Google and MSN (Large, Beheshti, & Moukdad, 1999; Large, Beheshti, & Rahman, 2002; Bilal, 2000,

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2001, 2002a; Large, Beheshti, Nesset, & Bowler, 2004). In some cases this might be because young people are unaware that children's Web portals exist, but even when they have encountered such portals, typically they do not use them. Is it possible to design Web portal interfaces in such a way that they appeal to young users and become their preferred entry point to Web-based information?

The interface to any digital information system—the means by which the user issues search and browse instructions and through which retrieved information is displayed—can be a major determinant in the success or failure of an information-seeking task as well as a mechanism through which assistance can be offered to the user. This article elaborates guidelines for the successful design of Web portal interfaces to be used by children when seeking information in an educational (rather than a leisure) context. Although it draws upon support from other researchers, it primarily is based upon our own research, in which we have worked with children in various ways in order to understand how they use interfaces, what problems they encounter in so doing, and what suggestions they themselves have for overcoming such problems. In particular, it will focus upon our work with students in the sixth grade of public elementary school (students of eleven or twelve years of age). Nielsen (2002), in his work with children and usability, has commented on the keen awareness that children have about their age relative to those even slightly younger or older than themselves. Our own studies support this observation. Caution therefore must be exercised in extending the following discussion either to much younger children or to older teenagers.

We shall not discuss in this article the equally important topic of Web site (in contrast to Web portal) interface design for children. Nielsen (2002) reminds us that very little is known about how children actually use Web sites or how to design sites that will be easy for them to use. He says that most Web site designs are "based on pure folklore about how kids supposedly behave—or, at best, by insights gleaned when designers observe their own children." Harbeck and Sherman (1999) propose seven principles that should be followed when designing Web sites for young children, and Agosto (2002) has developed a model of the criteria used by young people to evaluate individual Web sites.

Many authors have discussed interface design, and in such discussions it is not unusual to find an emphasis on the user. For example, Shneiderman (1998) argued that any design should be based upon an understanding of its intended users, and he includes age as one user characteristic alongside gender, physical abilities, education, cultural or ethnic background, training, motivation, goals, and personality. It is less common, however, to find in practice that interface design guidelines explicitly have taken into account youthfulness as a user characteristic, and even more unusual to involve the young users themselves in the design process.

Stevenson (2001) discusses several educational portals and assesses them in the light of eleven main categories that *she* considers critical for a children's portal. Broch (2000) examines Yahooligans! and Ask Jeeves for Kids in terms of children's cognitive and mechanical skills. McDermott (2002) reviews a variety of specialized subject portals that are relevant to students with homework assignments. Haycock, Dobor, and Edwards (2003) provide detailed evaluations of the twenty "most highly recommended and popular" portals designed explicitly for children's use on the Web, as well as short annotations on eleven others. Kuntz (2000), then manager of one children's portal, KidsClick (http://www.kidsclick.org), identifies five broad criteria that can be applied to evaluate children's search tools: database size, accountability, categorization, search access methods, and other features (like help, spell checking, and layout). Najjar (1998), in discussing educational multimedia user interface design, makes it clear that the guidelines were almost entirely based upon the opinions of (adult) experts rather than on the results of empirical research.

Designing for Children and Children as Designers

Not all interface designs, however, have excluded children from participation in the design process itself. For example, Druin (1996, 1999, 2002); Bilal (2000, 2002a); Hanna, Risden, and Alexander (1997); Hanna, Risden, Czerwinski, and Alexander (1999); Kafai (1999), Large, Beheshti, and Rahman (2002); Large, Beheshti, Nesset, and Bowler (2004); and Large, Nesset, Beheshti, and Bowler (in press) all have advocated a child-oriented approach to design. They argue that children have a lot to offer in the design process as a whole and that it is advisable to include them in it. Children can come up with ideas that adults might not think of (Druin, 1996; Scaife & Rogers, 1999), but the downside is that they may want things included in the design that are impossible to realize.

Bilal (1999) has compared the performance by grade seven students on three Web portals specifically designed for youthful users: Yahooligans!, Ask Jeeves for Kids, and Super Snooper. She concludes that, as novices, children should use the portals designed for them, but she also found that each of the three portals had its own strengths and weaknesses for information retrieval. In a later study of Yahooligans!, Bilal offers a number of suggestions to system designers, who "should develop search engines with powerful searching and browsing mechanisms that build on children's cognitive and physical behaviors to search, browse, navigate and explore information with certainty and positive affective behavior" (2000, p. 662). She proposes more instructions, search examples, a natural-language interface, output ranking, simple screen displays, context-sensitive help, spell checking, effective feedback, and an online tutorial.

In our work with children we have employed four methods to explore their thoughts and ideas relating to interface design: observation, interview-

ing, focus groups, and intergenerational design teams. These are not mutually exclusive, and in practice we have used more than one in a study.

Observation

Observation is a technique employed in user-centered design where the user is brought in after design completion to assess the design's impact on the user. Children can be observed directly by researchers as they employ interfaces to find information. Such observation may be direct—the researcher is present while the interface is being used. This offers several advantages. The researcher can see what is happening on the display screen but also can observe the children themselves, noting their body language as well as their verbal communication. It is also possible to discuss with the children their use of the interface. A potential problem with such direct observation may be that the observation becomes intrusive, with the presence of one or more researchers influencing the behavior of the children.

In our case we opted for indirect observation. In 1998 we captured on videotape the seventy-eight sessions (with a mean of twenty-six minutes per session) undertaken by fifty-three grade six students searching the Web in groups of two or three to find information for a class project. Although the primary purpose of this research was to explore the information-seeking behavior of the students, analysis of the videotapes provided insight into how the students used two adult (rather than children's) Web portals: AltaVista and Infoseek. It might be argued that this is also intrusive, but in practice it seems clear from the irreverent comments on occasion made by the children that they quickly forgot that searches were being recorded. The main drawback encountered was that we could not identify which student in the group was doing what, and we could not intervene to ask why a particular move had been selected. It also proved difficult and slow to analyze interface use from the videotapes as typically cursor moves were executed rapidly and frequently.

Interviews

Interviews are another technique favored in user-centered design. Individual interviews with children after an interface has been used can probe the "why" of interface use: unlike observation, it enables the researcher to delve into the reasons why an interface was used in a particular way, as well as to elicit any ideas from the children as to how it might be improved. The children's comments are likely to be more reflective in comparison with ideas expressed during the heat of the search. However, children may find it difficult to recall after the event exactly what they were thinking at the time, and this problem likely will be exacerbated if the interview is not conducted immediately after interface use.

In our case, exit interviews were employed in the same class project discussed above (observation). The grade six students were interviewed after the completion of their project using open-ended questions, and

these interviews were audiotaped and subsequently transcribed. Many of the questions related to Web content, but the interviews also collected student feedback on the efficacy of the AltaVista and Infoseek search engines used in this project.

Bilal (2002b, 2003) used a different approach. She had several grade seven students individually draw an interface on one side of a paper and list the purposes of the interface on the reverse side. After a short break the students used a commercial children's Web portal, Yahooligans!, to search for information. They then discussed what they liked and disliked about it and noted the features they would want to add to their original drawings. Bilal interviewed the students individually to discover their rationale for adding these features. She then repeated the same procedure with KidsClick, another children's Web portal.

Focus Groups

A focus group can be defined as an informal assembly of target people whose points of view are requested to address a selected topic (Vaughn, Schumm, & Sinagub, 1996). The goal is to elicit the perceptions, feelings, attitudes, and ideas of participants through group interaction that encourages a range of opinions. The focus group has a moderator who sets the scene for the session and controls the proceedings. It is widely agreed that focus groups can be used with children so long as they are older than around six years. Although here we did not go so far as to design portal prototypes, the focus group members were invited to go beyond a mere critique of existing portals; they were encouraged to suggest how they would like to improve such portals so as to make them more effective for young users.

In summer 2000 we established four focus groups, each including five or six children aged between ten and thirteen years, plus a moderator and a note taker, to evaluate four operational children's Web portals: Ask Jeeves for Kids, KidsClick, Lycos Zone, and Yahooligans! Two of the groups comprised all boys and two groups had all girls (following recommendations in the literature that in the case of young people it is preferable to use single-sex groups). The groups were encouraged to critique the portals as they used them to answer four questions, and the discussions were audiotaped and later transcribed. In 2004 another focus group of seven elementary school students from grades five and six and all eleven years old, again with a moderator and note taker, was asked to evaluate a Web portal previously designed by an intergenerational team (see below). In all cases these focus groups met just once and the session lasted for around one hour.

Intergenerational Design Teams

Observation, interviews, and focus groups have been employed to gather children's reactions to existing interfaces, whether operational or prototypes. The intergenerational design team approach goes a step further by involving children actively in the actual design process, employing what

Druin has called "Cooperative Inquiry." Here children are treated as full design partners in the team alongside the adults (Druin et al, 2001, 2003) The team of children and adults meets regularly with the goal of developing a prototype. Druin (2002) argues that when children are restricted to the role of informant they can only offer feedback without an opportunity to elaborate or build upon ideas: the intergenerational design team provides an opportunity to create rather than merely critique.

In our case we established an intergenerational team comprising eight student volunteers from grade six and three adult researchers. Through a combination of discussions, critiques of existing Web portals, brainstorming, and pen and paper drawings, the team designed a low-tech prototype Web portal over multiple sessions. This portal now has been built and tested by a focus group of five students aged eleven and twelve years (subsequently it will be evaluated more thoroughly using both observation as it is used to find information for a class project and several focus groups). Both the design session discussions (Large, Beheshti, Nesset, and Bowler, 2004; Large, Nesset, Beheshti, and Bowler, in press) and the resulting prototype provide insight into children's thinking about Web portal interface design.

The following design guidelines derive from five data sources gathered by us in the following ways:

- Observation of children using two "adult" Web portals
- Interviews with children who had previously used these two portals
- Focus group evaluation by children of four children's Web portals
- Design concepts as discussed and realized by an intergenerational team
- Focus group evaluation by children of the Web portal designed by the intergenerational team

Data were collected from different children over several years (the earliest in 1998 and the latest in 2004). Nevertheless, the similarities in findings suggest that, despite children becoming more familiar with the Web as an information resource, their criteria for a successful Web portal design have not much changed over this time period; where there is an indication of a possible shift, however, this will be discussed.

Design Guidelines for Children's Web Portals

The following discussion of Web portal interface design guidelines is organized under the following main headings: portal objectives, metaphor, visual design, icons, portal name, characterization, terminology, advertisements, retrieval capabilities, results display, online help, personalization, and interactivity. This categorization is based upon a design matrix for children's Web portals originally developed by Large, Beheshti, and Cole (2002).

Portal Objectives

A portal can have three possible objectives: to provide information, education, or entertainment, although any one portal can pursue more than one (Rosenfeld & Morville, 1998). While the objective of an entertainment portal would be to provide leisure and fun, and the objective of an educational portal would be to promote learning, the objective of an information portal, as its name suggests, is to retrieve information either to support leisure activities or, in the context of our studies, to support school-based projects and assignments.

A portal that has the objective of retrieving information for class assignments should focus upon this specific objective. Although entertainment features might be attractive to some children as offering a welcome temporary diversion from information searches, overall children tell us that their inclusion distracts them from the information task at hand. If entertainment aspects are incorporated into an information-based portal, they should be related in some way to the portal's main objective. For example, the grade six intergenerational team decided to incorporate into its portal a link to several Web-based quizzes but only because these quizzes were directly related to the portal's main objective of finding information about Canadian history (see Figure 1). Furthermore, it is entertainment features in Web portals (such as animation sequences) that children tend to find age sensitive and that are most likely to provoke criticism of portals as being too childish.

It may prove valuable to include educational objectives within a portal intended for information retrieval, but we cannot verify this from our studies with children as none of the portals evaluated incorporated educational goals to any extent. However, the children's strongly expressed desire to find information as quickly and effortlessly as possible suggests that again they might well find educational features distracting from their main task, as they do entertainment features.

We recommend that designers of Web portals for young users should seriously consider restricting a portal's subject focus. The operational portals evaluated by children in our studies were not subject restricted. However, the History Trek portal designed by the intergenerational team was confined to finding information about Canadian history. Although this decision initially was made by the researchers and not the children (largely for logistical reasons), in practice it greatly facilitated the team's task in deciding upon many design issues, such as the portal's name, screen layout, and even retrieval tools, as will be discussed more fully below.

It should be added that a major drawback of children's Web portals when compared with "adult" portals has been the relatively small numbers of Web pages that are accessible from them. The attempt to provide universal subject coverage, combined with the labor-intensive task of identifying pages suitable in content and style for children, typically has resulted

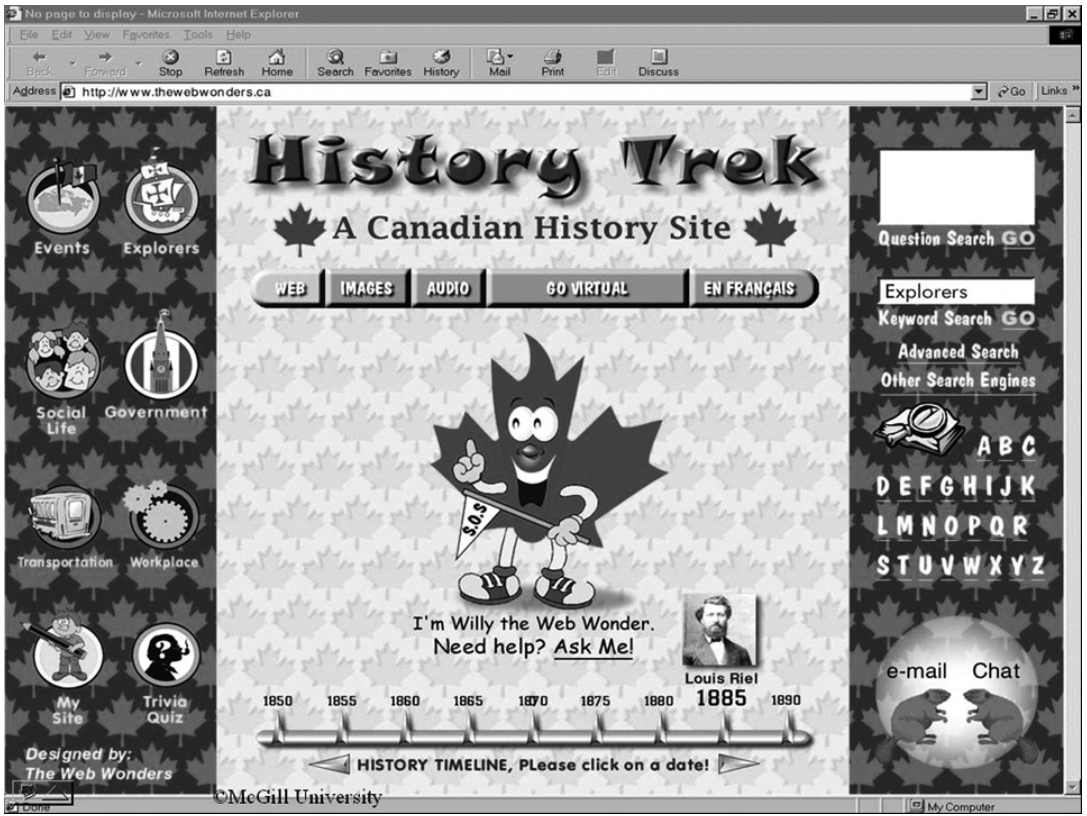

Figure 1. Homepage of History Trek (version 1.0) designed by the Intergenerational Team

in very superficial coverage of any topic on which students need to find information. Although not an interface issue, undoubtedly this is an important factor contributing to children's reluctance to use such children's portals and instead opting for portals like Google and MSN; the lack of child-friendly features in the latter is likely to be outweighed by the sheer quantity of information that likely can be found on the child's topic of interest (even though much of this information may be difficult for young readers to assimilate). Although History Trek's database only contains links to around 2,500 Web pages, it is able to provide sufficiently detailed information for its users because of its highly restricted subject focus (and in practice includes all that we have been able to find in English or French and appropriate for elementary school students). The focus group that undertook a preliminary evaluation of History Trek certainly considered this kind of restricted subject coverage to be a great virtue in comparison with the very general coverage of other portals they had used, whether "adult" or for children.

Metaphor

Metaphors are tools with the potential to reduce cognitive overload and help users apply their own mental models. Fleming (1998) describes them as one of the most powerful (though also one of the most misused) tools available to an interface designer. Metaphors should be based on familiar mental models so as to reduce cognitive effort rather than increase it. They may be used to provide a unifying framework for design as well as to facilitate learning by allowing users to draw on prior knowledge.

Children appreciate metaphors, but only if they are readily intelligible to them. The metaphor of an elderly butler assisting them to find information (as in Ask Jeeves for Kids) failed miserably as none of the children had encountered this literary figure from P. G. Wodehouse's novels; in this case the metaphor acted as a confusing distraction rather than a focusing tool. Metaphors are related to age and, as the Jeeves example suggests, culture. An appropriate metaphor can play a positive role in user orientation, but it must be carefully selected as it will tend to determine many other aspects of the interface's design.

Visual Design

A clear layout is important to ensure that individual features can readily be identified in the interface. For example, the help button on the MSN portal was considered too small to attract attention. The visual prominence of individual retrieval mechanisms (for example, positioning of keyword search boxes or subject directories) in our experience plays an important role in determining their relative levels of usage (see, for example, Bilal, 2000; Large, Beheshti, & Breuleux, 1998). The prototype interface design from the intergenerational team reflects the students' desire to avoid giving undue prominence to any one of the various searching techniques, and

although the interfaces present many features, their layouts avoid clutter (see Figure 1).

Children tend to dislike white, empty space on the screen, or even the use of white as a background color. In contrast, they do like bright colors that immediately catch the user's attention, though they do not necessarily agree on which colors meet this criterion. Interface personalization (see below) is a good way to cater for this. Children's comments on color combinations often run counter to widely recognized guidelines for the use of color in interfaces (see, for example, Galitz, 2002; Mandel, 1997) as well as contradicting the results from experimental studies (at least with adults) on screen readability, where dark colors superimposed on a light background are recommended (Muter, 1996). At the same time, it is not enough for designers to use as many color combinations as possible in the belief that this will make an interface instantly popular with young users. A colorful interface is necessary but not sufficient to ensure a successful children's Web portal.

The designers of children's Web portals such as Lycos Zone or Yahooligans! obviously believed that graphic devices are essential in an interface intended for children, and they may have been correct. The children in our earlier focus groups reacted positively to graphics as used, for example, by Lycos Zone (see Figure 2), and indeed they were critical of portals that did not make extensive use of them, such as KidsClick (see Figure 3). The children in the subsequent intergenerational design team, however, opted for graphics only if they contributed in some way to the overall visual design; gratuitous graphics were not popular. For example, the team chose two beavers, animals with a Canadian connotation, facing each other as if in conversation, to represent email and chat facilities in its portal prototype (see Figure 1). The use of cartoon-like figures in some children's Web portals, however, were considered "childish" or at odds with children's sense of rightness; for example, the mascot who was skateboarding in the Alfy portal (http://www.alfy.com) was criticized for not wearing a helmet. Cartoon figures also were seen as being potentially distracting from the portal's objective of finding information (see above under Portal Objectives).

Animated characters are becoming increasingly popular as interface presentation agents (Shaw, LaBore, Chiu, & Johnson, 2004). Animation should be used sparingly, however, in a portal whose objective is information retrieval. The intergenerational team's prototype has only one animation; the SOS flag held by the portal mascot moves from left to right and back. The team was quite explicit that it did not want gratuitous animation—the flag waving is intended to draw attention to the mascot's role in representing the portal's help facilities. The team wanted to minimize unnecessary distraction from the portals' primary information-finding task. Ironically, the focus group that tested this prototype was only unanimously critical of one design aspect in the entire portal, and that was this animation. It was con-

Figure 2. Lycos Zone (As of Summer 2000)

sidered by some children to be distracting and superfluous. The 2000 focus groups had been more enthusiastic about animation: they thought the more animation, the better, and criticized interfaces with little animation.

Based on these findings, the tendency of adult designers to associate young people, Web portals, and gaudy, animated features is misplaced. At the same time, the students in the 2004 focus group, who used Google for their everyday searching, found History Trek more attractive and appealing. Designers, then, must strike a balance between a plain and unimaginative but functional design on the one hand, and a gratuitously colorful and animated design that makes it both narrowly age specific and potentially distracting from its primary purpose—information retrieval.

It may be that in the intervening three years between the year 2000 focus group and the design team judgments, children have become less impressed by mere color and movement for its own sake and are now more interested in portal functionality. The focus groups had criticized KidsClick (see Figure 3) for its dullness, but the latter's designer, Kuntz (2000), may have been simply ahead of his time in his belief that gratuitous color and movement simply distract users.

Children also have opinions about the fonts used in an interface. In

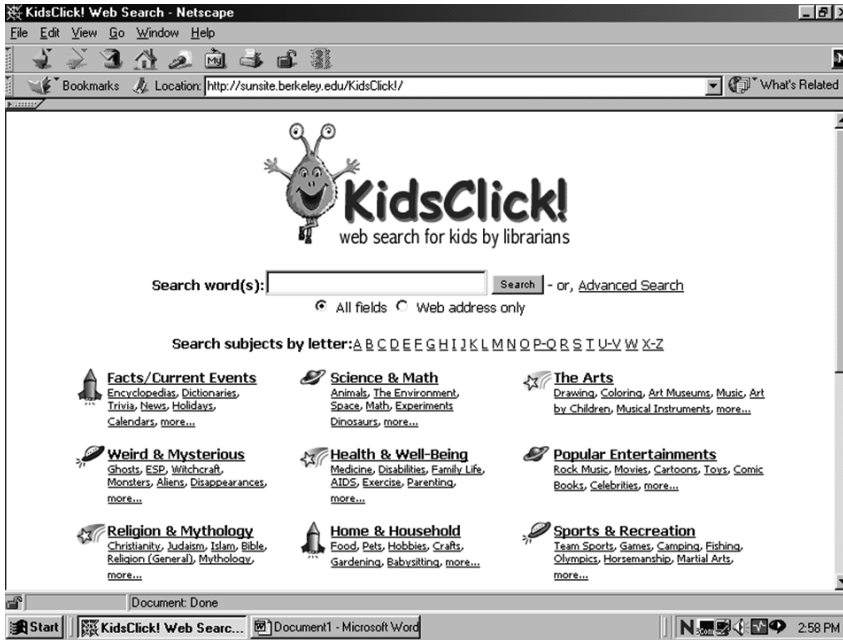

Figure 3. KidsClick (As of Summer 2000)

both focus groups and the design team, the children commented on font choices, especially the need for font sizes that are clearly legible on the screen. It is interesting that young users should share the concerns of old users at least on this matter.

Icons

Icons are popular with children but tend to be interpreted very literally and therefore criticized if not accurately matching the associated concept. For example, an icon of a TV set in Yahooligans! was dismissed as being much narrower than its associated concept, "Arts and Entertainment" (see Figure 4), as was an icon showing children but representing "People." Icons need to be carefully selected and given a text label to avoid any misinterpretations.

Portal Name

What's in a name? For children, at any rate, the name really does matter, as it is an important means of gaining users' attention. It should convey the purpose of the portal to its target audience and, ideally, also be fun (the focus group students liked the name "Yahooligans!"). A well-received name instantly increases the portal's attractiveness (and vice versa). We have seen above that the literary character Jeeves is not familiar (at least to Canadian

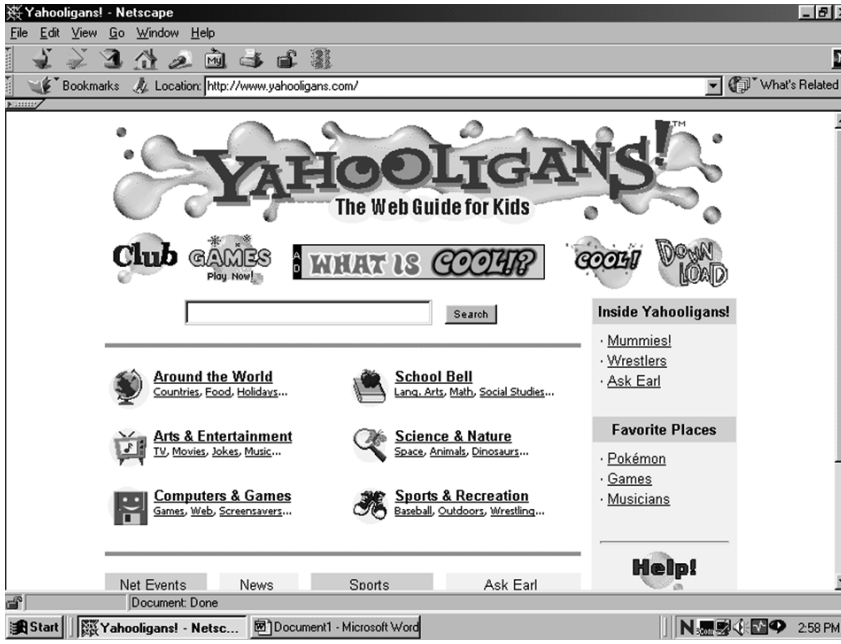

Figure 4. Yahooligans! (As of Summer 2000)

children), and therefore the portal name "Ask Jeeves for Kids" conveys nothing to them (see Figure 5). The intergenerational design team chose a name for its portal prototype—History Trek—that directly related to its purpose. The name should be prominently displayed on the screen (as in Yahooligans!, as shown in Figure 4) and not lost among other graphics. A related issue is the predictability and memorability of the portal's URL. In this respect, the focus groups gave KidsClick's former URL (http://sunsite.berkeley.edu/kidsclick!) a low rating.

Characterization

Mascot characters are popular with children as long as they are considered appropriate for their age group and play a role in the interface. The intergenerational design team members chose a mascot for their prototype portal that was very much in character with the overall portal design based on a Canadian theme—a personified maple leaf—and which had a purpose—to activate help (see Figure 1). Any character included in the interface should be used consistently and throughout the entire portal rather than appearing only on the home page. Young users appreciate the presence of a character that will give a personality to the portal, but selection and design of such a mascot is likely to prove idiosyncratic and

Figure 5. Ask Jeeves for Kids (As of Summer 2000)

subjective to individual users (again, interface personalization can be invoked here).

Terminology

Terminology used in the interface, it goes without saying, should be suitable for the target age group. For example, the intergenerational design team members were keen to offer interface personalization but were unfamiliar with this term and chose instead "My Site" as the best representation. Textual labeling itself must be determined with care. The intergenerational team had opted to label the mascot on the homepage "I'm Willy the Web Wonder. Need help? Ask me!" This confused the focus group that subsequently tested the portal; they thought it meant that a search for information on the Web should begin with a click on Willy.

Advertisements

All the children in our various studies were unanimous in their dislike of advertisements in children's portals. The intergenerational design team, however, was less hostile than the earlier focus groups, unless the advertisements were pop-up advertisements. This might be explained by their greater familiarity with the Web, and its ubiquitous use of advertising, compared with the students in the earlier focus groups.

Retrieval Capabilities

It might be assumed that young users would find it easier to express search queries as complete, natural-language sentences rather than having to identify one or several keywords in which to encapsulate their information need. In practice, however, we have found that children take readily to keyword searching. That is not to say that they eschew a natural-language approach, and indeed the grade six intergenerational team included "question" searching along with keyword searching options in its prototype interface (see Figure 1). But they appear to choose keyword searching when they can readily come up with keywords, reserving natural-language questions for instances when this proves difficult. It may be simply that they are much more familiar with keyword searching, or that their occasional experience with retrieval systems that claim to accept natural-language questions has not been positive.

Spelling prowess obviously will vary according to age and individual ability, but it should be required that any children's portal incorporates some form of spell checking. Ideally children want the portal to automatically correct their spelling and find what they want without any intermediate steps. At the very least, the portal should respond to a misspelling by presenting them with an array of alternatives, prefaced by "Did you mean . . . ?" (much as do many "adult" portals).

Subject directories are appreciated as long as they mirror the way that students themselves would represent their own information needs (Hirsh, 2004). That is to say, a subject directory is useful if it gives direct access to the subjects currently under study in the curriculum. Students had little patience with a directory that required them either to navigate multiple hierarchical levels to reach the desired information or that was at odds with their own categorization. The design team students were able to identify potentially appropriate categories because the History Trek portal not only was designed specifically for grade six students but also to find information on one specific topic—Canadian history. Nevertheless, the focus group students who tested History Trek did not always find matching their information needs against these categories straightforward. When faced with a portal whose subject categories are intended to encompass the entire universe of knowledge, children are much less likely to appreciate subject categories as a simpler entry point than keywords. The cognitive effort required to select the correct subject at each hierarchical level is likely to prove more demanding than thinking of keywords and probably will lead to poorer results. More research will be required into exactly how children categorize and hierarchically arrange concepts before truly effective subject directories can be constructed.

Bilal (2000) studied the ability of middle school children using the Web to handle fact-based queries. She believes that the high percentage of keyword searching (in contrast to selections from hierarchically organized

subject directories) undertaken by the students was due to the factual nature of the task they were given, with the assignment containing concrete keywords. Subject content, then, influenced the relative importance of searching rather than browsing as a means of finding information.

Alphabetical searching—the possibility to click on a letter to search for a concept—is popular with children; although they must still think of a suitable keyword, they do not need to be able to spell it correctly (an example of this approach is shown in Figure 1). The design team also included a scrollable timeline in History Trek to help find major events in Canadian history according to their dates. The year 2004 focus group that tested the portal, however, did not even notice this timeline (admittedly, they used the portal only once and for one hour); perhaps this was because they were not used to encountering such a retrieval device in a portal.

In an earlier study (Large, Beheshti, Breuleux, & Renaud, 1994) we conducted with grade six children and a CD-ROM-based encyclopedia, we found that the children were able to determine which of several different retrieval options was likely to be the most effective for a given search (in this case they could choose from keyword search, title browsing, and using subject categories).

Results Display

As Kafai and Bates (1997) pointed out, sometimes titles and descriptions returned by portals can be misleading and difficult for elementary school students to evaluate. Homonyms in particular create problems for students; they ideally should be tackled through categorizing results by the homonym's individual definitions. For instance, in the 2000 focus groups the students were confused when searching for "tigers" to retrieve Web pages dealing with the Detroit Tigers baseball team.

Display should be limited to between ten and twenty hits per screen. The title and summary of the pages should be short, informative, and written in child-friendly language. Search terms should be highlighted within the displayed hits. History Trek incorporates such features in its display screens (see Figure 6).

Output ranking is important. Typically young students place a very high value on precision and dislike having to scroll through long hit lists in order to identify relevant pages. Furthermore, they are used to sophisticated ranking algorithms on the "adult" portals they use. The indicators of reading levels included in the KidsClick Web portal were popular. One student in the design team suggested an area on the screen that would show sites already visited as a kind of search history, but this idea was not taken up by the team as a whole nor incorporated into the prototype.

The design team viewed and discussed the graphical presentation of hits used by Web Brain (http://www.webbrain.com) and PubMed (http://www.ncbi.nlm.hih.gov/entrez/query.figi). In neither case did they express

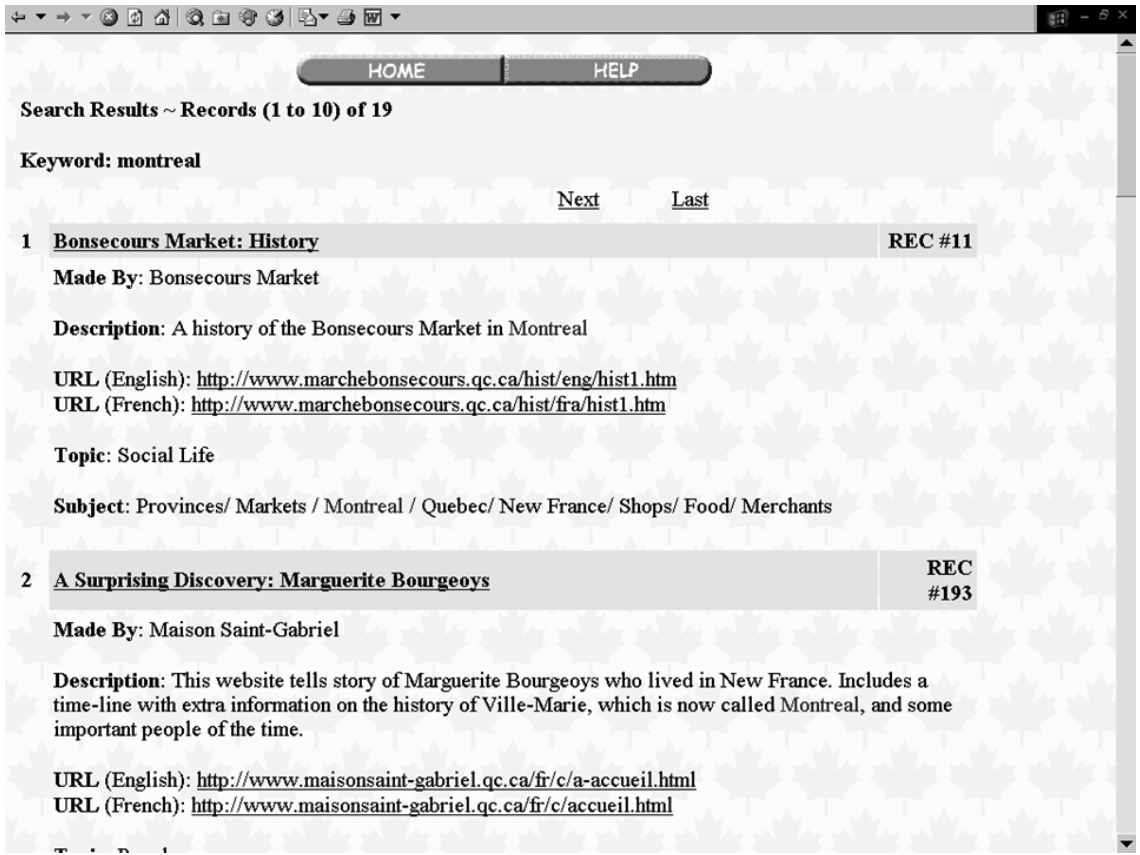

Figure 6. Results Display Screen, History Trek (Version 1.0) as designed by the Intergenerational Team

any enthusiasm for this technique, claiming that "it looks really adult" and "it has too much that you don't need." It would be unwise to conclude from these negative reactions, however, that visualization has no merit in a children's portal. The students found it difficult to separate design from content; the fact that these two portals were presenting complex concepts and the relationships between them may have influenced negatively the children's appreciation of the underlying design approach that might equally be used with children's information content.

Online Help

In general, people do not read online documentation (help pages) voluntarily (Nielsen, 2000), and our research has confirmed this observation for children. For example, in 78 separate search sessions extending over 2,041 minutes that we captured and analyzed (Large, Beheshti, & Moukdad, 1999), grade six students only accessed help on one occasion (see also Bilal, 1999, 2000). This is not because children do not perceive themselves as needing help but rather because the specific kind of help they want—how to turn a failed search into a successful search, taking the form, for example, of substituting alternative keywords or subject categories that will immediately retrieve the sought information without further input from the user—is not provided by Web portals. They want a precise solution to be provided for their precise problem. Instead they are given general explanations of the portal's retrieval capabilities, perhaps with a few examples thrown in to illustrate various searching techniques. Furthermore, such explanations often are presented in a way that is difficult for young users to understand; one boy suggested to us, for example, that help should be delivered through a movie that shows someone searching (rather like the technique used in some computer games). The members of the design team criticized the help features available from several children's portals: Yahooligans!, for example, has "nothing on searching," and Lycos Zone suggests alternative search terms but does not automatically implement them. The students thought children would not understand that KidsClick's "search tools" or IPL KidSpace's "searching tools" meant help, and as a result would likely ignore them. Ideally help facilities should be context sensitive, but this may prove relatively difficult to implement in an online environment. Any online documentation must be searchable to allow users to seek specific help topics.

In fact, in their own design the students stressed the importance of good help; the History Trek help screen consists of four help components: an explanation of how the site works, information about the design team (the "Web Wonders"), an opportunity to contact a subject expert and, finally, the most important element for them, "help with my search," which they intend should do exactly that—offer specific guidance on the search at hand. Of course, successfully achieving this objective is another matter!

Personalization

Children should be offered an opportunity to personalize the Web portal interface. First, this is important because reactions to things like mascot, colors, screen layout, icons, and animation are personal and will differ from child to child. Furthermore, such differences are likely to be more strongly drawn among children than adults. Certainly in the design team, areas like color and mascot selection were the most difficult about which to develop a group consensus. Personalization is the way to respond to individual preferences. Second, personalization is a way to increase a portal's appeal to wider age groups. It is the presentation aspects of the portal that are most age-sensitive, and what is attractive to one age group is "infantile" or "too grown up" for another. Third, from our year 2000 focus group studies, there is evidence to suggest that presentation is also related to gender, and personalization is a way to cater to the tastes of both girls and boys. (Passig and Levin [1999] also report different preferences between boys and girls for color use in interfaces.) The portals reviewed by these focus groups were criticized for the total absence of personalization capabilities; the intergenerational team design includes personalization options, such as different costumes for the mascot to wear (accessed from the "My Site" icon as shown in Figure 1).

Interactivity

Should a children's Web portal include interactive features such as email and chat facilities? On the one hand, these features enable students to interact one with another, to exchange information, and to discuss class projects. Especially when schools often favor group rather than individual assignments, it can prove useful for both students and teachers that the former can communicate with each other, either within one class or on a much broader geographical scale. They can also contact subject experts in order to discuss projects with them. On the other hand, interactivity, like games and animation, can be a distraction from the primary information-seeking task. Especially when being used from the school classroom or information technology lab, teachers may prefer to eliminate any temptation for their students to email and chat with friends. Furthermore, the children themselves are aware, from both teachers and parents, of the dangers lurking on the Web, especially in chat rooms. For example, the students in the intergenerational design team initially were skeptical about such interactivity. After some discussion, however, they could appreciate the value of exchanging information and ideas with fellow students, teachers, librarians, and other subject experts. Even then, though, they only proposed to include email and chat on their own prototype if security provisions (through user authentication) could limit access to bona fide users such as fellow students or identified adults with relevant subject expertise.

Multilingualism

All the students with whom we have worked at various times have been functionally bilingual in English and French. Furthermore, almost all of them attended schools in which teaching is divided between these two languages. In such an environment they were unanimously in favor of a bilingual approach as a minimum (several suggested the inclusion of additional languages). A portal interface, therefore, should be available in more than one language. The History Trek portal, for example, has a prominent button by which the interface can be toggled between English and French (see Figure 1). If a bilingual or multilingual approach is adopted, it should be applied throughout the entire interface. This means that all access screens, help pages, subject directories, etc., should be available in all the selected languages. Bilingual environments obviously are not confined to Quebec; in the United States, for example, it would seem worthwhile for designers to consider the merits of bilingual English and Spanish portal interfaces. Designers should be warned, however, that both at the development stage and in any subsequent interface modifications, minor or major, any changes will have to be replicated in all the language versions.

Interfaces for the Future

Interface design continues to evolve, though not all developments will be as dramatic as the shift from text-based to graphical interfaces. In terms of children's Web portals it is possible to discern several areas of current research that offer new opportunities for interfaces to facilitate the task of information retrieval.

Researchers are now exploring interface designs that rely heavily upon visualization rather than linear text to present information. Children and young adults in particular tend to rely on visual information or visual cues rather than textual information (Fidel, et al., 1999; Hirsh, 1999; Large & Beheshti, 2000). Savage-Knepshield and Belkin (1999) predict that information visualization will be very much a part of the next information retrieval wave and will dramatically impact children's information retrieval. Our intergenerational design team did not respond positively when shown Web-based examples of visual displays such as WebBrain or PubMed. This might be explained, however, by the children's inability to appreciate the underlying possibilities of such visual displays when they were being applied to adult information resources that the children found difficult to understand.

Computer game enthusiasts are familiar with three-dimensional (3D) action games where players walk through virtual worlds and have the illusion of being themselves in those worlds. Christoffel and Schmitt (2002) discuss interfaces that use such real world metaphors. Their interface is based on an action game called Quake II, but instead of players killing their

enemies and ultimately saving the world, they can move around a library, browse its bookshelves, select books from them, and see their contents. Our intergenerational design team discussed such a 3D interface design for a Web portal, where users would move through a first-person 3D (or virtual, as the students called it) environment, browsing for information. In the 3D interface, as in a computer game, users would explore the Web by moving through virtual space. All but one of the students were extremely enthusiastic about such an approach so long as response times were not degraded, but they thought that such a 3D interface should complement rather than replace any conventional portal interfaces. We are currently designing such a 3D portal for eventual evaluation by elementary school students (Beheshti, Large, Nesset, & Bowler, 2004). According to Nielsen (2002), children like geographical navigational metaphors such as pictures of rooms, villages, and "other simulated environments that serve as an overview and entry point to various site or subsite features."

Another interesting area is the incorporation of active user assistance within a portal's interface. Abbas, Norris, and Soloway (2002) discuss the ARTEMIS Digital Library at the University of Michigan, which has been in use since 1997 by science students in grades six through twelve (approximately twelve to eighteen years old). ARTEMIS includes a practice area, called the Scavenger Hunt, where students learn how to use the various browse and search features of the interface. The interface also includes "scaffolding" features that help reduce the cognitive load for young users: for example, a workplace to save and organize search results and Web page links, a means to share with other students those resources that are of interest, the opportunity to view results of previous searches, and a dictionary that can be consulted as needed (several of these ideas were proposed by individual students in our intergenerational design team but were not incorporated into the prototype).

Shaw, LaBore, Chiu, and Johnson (2004) discuss the use of digital puppets that can interact with users through speech and gestures, modeling the kinds of dialog and interactions that occur during apprenticeship learning and one-to-one tutoring. These build upon the natural human tendency to interact socially with computers and can respond both to motivational and cognitive factors by increasing learner curiosity and interest and offering help. Although Shaw and her colleagues are interested in learning environments, such techniques offer interesting possibilities for children's Web portals, especially in providing the kind of interactive, context-sensitive help that children say they want.

A different kind of interface development is likely to be spurred by information technology advances. As the Web is accessed not just from computer display screens but, for example, from handheld devices such as cellular telephones, new interface challenges will be posed. The small

screen limitations will require of designers new approaches to information retrieval and display functions.

Concluding Thoughts

Designing Web portals for children is a difficult and challenging task. By using unobtrusive observations, interviews, and focus group studies, researchers can obtain data and feedback for effective design criteria. It is only through intergenerational design teams, however, that Web portals can be constructed to meet the specific needs of children. Intergenerational teams consist of a number of adults and children who meet regularly over a period of time to tackle design and other issues for creating a Web portal. These teams should rely on a comprehensive framework as the basis for discussing design issues. In our case, we used a number of elements that were included in a design matrix from our previous research and modified them to suit our specific purpose in creating a Web portal for classroom projects on Canadian history for grade six students. These elements consist of the objectives of the portals (education, information, or entertainment), use of metaphors and icons, visual design of the interface, the name of the portal and its URL, characterization and personalization, consistent and appropriate terminology, retrieval capabilities, results display, interactivity in terms of email and chat rooms, online help facilities, advertisements, and multilingual capabilities. Extensive discussions of these elements within the intergenerational team allowed us to create a relatively sophisticated and yet usable Web portal for children. Preliminary tests through focus group studies indicate that the implementation of the portal is successful. In the near future we will test the portal in a real operational environment in a classroom. The results of the tests will help us to reassess the methodology of using intergenerational teams and to modify, if necessary, the guidelines for designing children's Web portals.

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